Package ‘evbsreg’

September 18, 2026

Type Package

Title Local Influence Diagnostics for the Extreme-Value Birnbaum-Saunders Regression Model

Version 1.2.0

Date 2026-09-17

Description Implements local influence diagnostics for the Extreme-Value Birnbaum-Saunders (EVBS) regression model: joint maximum likelihood estimation, conformal normal curvature diagnostics under three perturbation schemes (case-weight, response variable, and explanatory variable), randomized quantile residuals with simulation envelope, Monte Carlo simulation utilities, and publication-quality density and diagnostic plots. Version 1.1.0 adds the density, distribution and quantile functions, the finite upper endpoint, return levels and expected shortfall, block bootstrap standard errors for serially dependent series, local influence diagnostics for the generalized extreme-value regression model, and a GAMLSS family allowing the tail-shape parameter to depend on covariates. Version 1.2.0 adds a prospective control chart for endpoint identifiability. The methods are described in Ospina, Lima, Barros, and Macedo (2026, submitted) and are applied to monthly maximum wind gust data from Itajai, Brazil.

License MIT + file LICENSE

URL https://github.com/Raydonal/evbsreg, https://raydonal.github.io/evbsreg/

BugReports https://github.com/Raydonal/evbsreg/issues

Encoding UTF-8

LazyData true

Depends R (>= 4.0.0)

Imports stats, graphics, SpatialExtremes, ggplot2

Suggests gamlss, grDevices, knitr, rmarkdown, testthat (>= 3.0.0)

VignetteBuilder knitr

Config/roxygen2/version 8.0.0

NeedsCompilation no

Author Raydonal Ospina [aut, cre] (ORCID:
<https://orcid.org/0000-0002-9884-9090>)

Maintainer Raydonal Ospina <raydonal@de.ufpe.br>

Repository CRAN

Date/Publication 2026-09-18 06:40:38 UTC

Contents

`cnc_diagnostics` *Conformal Normal Curvature Local Influence Diagnostics*

Description

Computes conformal normal curvature (CNC) local influence diagnostics from a fitted EVBS regression model. The CNC approach of Poon and Poon (1999) produces a scale-invariant influence measure bounded in $[0, 1]$; the aggregate contribution statistic of Zhu and Lee (2001) attributes curvature to individual observations and is compared against interpretable reference thresholds.

Usage

```
cnc_diagnostics(fit)
```

Arguments

`fit` A fitted model object returned by `evbsreg.fit`. The function uses the influence matrix `fit$B`.

Details

The function performs the symmetric eigendecomposition of the influence matrix B, normalizes the eigenvalues to unit norm, and for each threshold $q = 1, \ldots, 7$ identifies the q-influential eigenvectors (those whose normalized eigenvalue exceeds $q/\sqrt{n}$). The aggregate contribution of observation j at level q, $B_j(q)$, is the sum of the normalized eigenvalues weighted by the squared eigenvector coordinates of observation j.

Value

A list with components:

`eigenvalues` Numeric vector: the raw eigenvalues of B.

`eigenvalues_norm` Numeric vector: the absolute normalized eigenvalues $|\lambda_i^*|$.

`eigenvectors` Matrix: the eigenvectors of B (columns).

`thresholds` Numeric vector of length 7: the reference thresholds $q/\sqrt{n}$ for $q = 1, \ldots, 7$.

`Bj` Matrix of dimension $8 \times n$: rows 1–7 hold the aggregate contributions $B_j(q)$ for $q = 1, \ldots, 7$; row 8 holds the global aggregate over all eigenvectors.

`bq` Numeric vector of length 8: the reference values $b(q)$ for flagging influential observations at each level.

`n` Integer: the sample size.

References

Poon, W.-Y. and Poon, Y. S. (1999). Conformal normal curvature and assessment of local influence. *Journal of the Royal Statistical Society, Series B*, 61, 51–61.

Zhu, H. and Lee, S. (2001). Local influence for incomplete-data models. *Journal of the Royal Statistical Society, Series B*, 63, 111–126.

Ospina, R., Lima, J. I. C., Barros, M., and Macedo, A. M. S. (2026). Local influence diagnostics for the extreme-value Birnbaum-Saunders regression model. *Submitted*.

See Also

`evbsreg.fit`, `plot_cnc`.

Examples

```
data(itajai)
X <- cbind(1, itajai$pressure)
fit <- evbsreg.fit(X, itajai$wind)
diag <- cnc_diagnostics(fit)

## Top normalized eigenvalues
head(diag$eigenvalues_norm, 4)

## Observations flagged at q = 7
which(diag$Bj[7, ] > diag$bq[7])
```

---

cnc_diagnostics_gev — *Conformal normal curvature diagnostics for the GEV regression model*

Description

Local influence diagnostics under case-weight perturbation for the GEV regression model, obtained from the individual score contributions (see `gev_scores`) and the observed information.

Usage

```
cnc_diagnostics_gev(object)
```

Arguments

`object`	An object of class gevreg from `gevreg.fit`.

Value

A list with the normalized aggregate contributions `Bj`, the threshold `2/n`, and the indices of the flagged observations.

Examples

```
data(itajai)
X <- cbind(1, itajai$pressure - mean(itajai$pressure))
fit <- gevreg.fit(X, itajai$wind)
d <- cnc_diagnostics_gev(fit)
head(order(d$Bj, decreasing = TRUE))
```

---

devbs *Density of the Extreme-Value Birnbaum-Saunders distribution*

Description

Probability density function of the EVBS distribution on the response (positive) scale. The EVBS variate T satisfies $Z = (2/\alpha)\sinh\{(\log T - \eta)/2\} \sim \mathrm{GEV}(0, 1, \gamma)$.

Usage

```
devbs(t, eta, alpha, gama, log = FALSE)
```

Arguments

`t`	Vector of positive quantiles.
`eta`	Location on the log scale, typically $x^\top\beta$.
`alpha`	Positive shape (scale) parameter.
`gama`	Extreme-value shape parameter.
`log`	Logical; if `TRUE`, the log-density is returned.

Details

The extreme-value index of the *response* T is 2γ, not γ. The transformation preserves the max-domain of attraction but doubles the tail index, because $T \approx \beta\alpha^2 Z^2$ in the upper tail.

Value

A numeric vector of (log-)density values.

Examples

```
devbs(c(10, 20, 30), eta = 2.58, alpha = 0.19, gama = -0.16)
```

dlogEVBS *Density of the log-EVBS distribution (GAMLSS parametrization)*

Description

Density of the log-EVBS distribution (GAMLSS parametrization)

Usage

```
dlogEVBS(x, mu = 0, sigma = 1, nu = 0, log = FALSE)

plogEVBS(q, mu = 0, sigma = 1, nu = 0, lower.tail = TRUE, log.p = FALSE)

qlogEVBS(p, mu = 0, sigma = 1, nu = 0, lower.tail = TRUE, log.p = FALSE)
```

Arguments

`x, q, p`	Vector of quantiles / probabilities.
`mu`	Location on the log scale.
`sigma`	Positive scale parameter.
`nu`	Extreme-value shape parameter.
`log, log.p`	Logical; return the log-density / log-probability.
`lower.tail`	Logical; if `TRUE`, probabilities are $P(Y \leq y)$.

Value

A numeric vector.

envelope_qq *Normal Probability Plot with Simulation Envelope*

Description

Produces a normal probability (QQ) plot of the randomized quantile residuals together with a simulated envelope, reproducing the residual diagnostic figure of the paper. Points falling outside the envelope indicate poor fit.

Usage

```
envelope_qq(X, t, nrep = 100)
```

Arguments

`X`	A numeric design matrix with an intercept column.
`t`	A numeric vector of strictly positive responses.
`nrep`	Number of simulated samples used to build the envelope (default `100`).

Value

Invisibly, a list with components `r` (observed residuals), `e1` and `e2` (lower and upper envelope bounds), and `med` (envelope median). A base-graphics plot is produced as a side effect.

References

Atkinson, A. C. (1985). *Plots, Transformations and Regression*. Oxford University Press.

See Also

`rqrandomized`.

Examples

```
data(itajai)
X <- cbind(1, itajai$pressure)
envelope_qq(X, itajai$wind, nrep = 100)
```

`evbsreg.fit` *Fit the Extreme-Value Birnbaum-Saunders Regression Model*

Description

Fits the log-Extreme-Value Birnbaum-Saunders (log-EVBS) regression model by joint maximum likelihood estimation. All parameters $(\beta^\top, \alpha, \gamma)^\top$ are estimated simultaneously using the BFGS algorithm with an analytic score function. Standard errors are computed from the analytic observed Fisher information matrix, which is numerically stable even for ill-conditioned design matrices.

Usage

```
evbsreg.fit(x, t)
```

Arguments

`x`	A numeric design matrix of dimension $n \times p$. It **must** include an intercept column (a column of ones). Each row corresponds to one observation and each column to one covariate.
`t`	A numeric vector of length n containing the **strictly positive** responses (e.g. wind gust speeds). Internally the model is fit to `log(t)`.

Details

The EVBS regression model links the location parameter of the log-EVBS distribution to a linear predictor $\mu_i = x_i^\top \beta$. The shape parameter $\alpha > 0$ controls dispersion and the tail-shape parameter γ governs the Generalized Extreme Value tail behaviour (Frechet for $\gamma > 0$, Gumbel for $\gamma = 0$, Weibull for $\gamma < 0$).

Initial values are obtained from `lm.fit` applied to the log response, together with the moment-based starting point $\alpha_0 = \sqrt{(4/n) \sum \sinh^2((y_i - x_i^\top \beta_0)/2)}$ and $\gamma_0 = 0.01$. Optimization uses `optim` with `method = "BFGS"`, the analytic score, and tolerance `reltol = 1e-12`.

The observed Fisher information is assembled analytically (see the package vignette and the paper's appendix) and inverted via a Cholesky factorization, falling back to `solve` if the matrix is not positive definite.

Value

A list of class `"evbsreg"` with components:

`coeff` Numeric vector of length $p + 2$: the full parameter vector $(\beta_0, \ldots, \beta_{p-1}, \alpha, \gamma)$.

`betahat` Numeric vector of length p: the regression coefficients.

`alphahat` Scalar: the estimated shape parameter $\hat{\alpha}$.

`gamahat` Scalar: the estimated tail-shape parameter $\hat{\gamma}$.

`stderrors` Numeric vector of length p: standard errors of the regression coefficients.

`stderroralpha` Scalar: standard error of $\hat{\alpha}$.

`stderrorgama` Scalar: standard error of $\hat{\gamma}$.

`zstats` Numeric vector: Wald z-statistics for the regression coefficients.

`pvalues` Numeric vector: two-sided p-values for the regression coefficients.

`muhat` Numeric vector of length n: fitted linear predictor on the log scale.

`xi1, xi2` Numeric vectors of length n: helper quantities ξ_{i1}, ξ_{i2} evaluated at the MLE.

`observmatrix` Numeric matrix of dimension $(p + 2) \times (p + 2)$: the analytic Hessian $\ddot{\ell}(\hat{\theta})$ of the log-likelihood (negative definite at the maximum).

`hessian` Numeric matrix: identical to `observmatrix`; provided under the conventional name. The observed Fisher information is `-hessian`.

`inv` Numeric matrix of dimension $(p+2) \times (p+2)$: the inverse of the observed Fisher information `-hessian`, i.e. the asymptotic variance-covariance matrix of $\hat{\theta}$.

`B` Numeric matrix of dimension $n \times n$: the influence matrix $B = \Delta^\top (-\ddot{\ell})^{-1} \Delta$ for the case-weight perturbation scheme, consumed by `cnc_diagnostics`.

`nobs` Integer: the number of observations n.

`npar` Integer: the number of parameters $p + 2$.

The returned object has class `"evbsreg"` and has a `print.evbsreg` method that displays a coefficient table.

References

Ospina, R., Lima, J. I. C., Barros, M., and Macedo, A. M. S. (2026). Local influence diagnostics for the extreme-value Birnbaum-Saunders regression model: methodology, validation, and application to anomalous wind gusts. *Submitted*.

Leiva, V., Ferreira, M., Gomes, M. I., and Lillo, C. (2016). Extreme value Birnbaum-Saunders regression models applied to environmental data. *Stochastic Environmental Research and Risk Assessment*, 30, 1045–1058.

Cook, R. D. (1986). Assessment of local influence. *Journal of the Royal Statistical Society, Series B*, 48, 133–169.

See Also

`cnc_diagnostics` for influence diagnostics, `rqrandomized` for residuals, `itajai` for the example dataset.

Examples

```
data(itajai)
X <- cbind(1, itajai$pressure)
fit <- evbsreg.fit(X, itajai$wind)

## Parameter estimates and standard errors
round(fit$coeff, 4)
round(c(fit$stderrors, fit$stderroralpha, fit$stderrorgama), 4)
```

`evbsreg.fit.mc` *Monte Carlo Simulation Study for the EVBS Regression Model*

Description

Runs a Monte Carlo simulation that evaluates the finite-sample properties of the joint maximum likelihood estimator of the EVBS regression model under one of three scenarios.

Usage

```
evbsreg.fit.mc(
  m,
  n,
  beta0,
  beta1,
  alpha,
  gama,
  scenario = c("canonical", "leverage", "robustness"),
  semente = 2023
)
```

Arguments

`m` Number of Monte Carlo replicates (the paper uses `5000`; set to a smaller value such as `500` for a quick check).

`n` Sample size for each replicate (the paper uses 60, 120, 180).

`beta0` True intercept β_0.

`beta1` True slope β_1.

`alpha` True shape parameter α.

`gama` True tail-shape parameter γ.

`scenario` Character string selecting the design:

- `"canonical"` covariate $x \sim U(0, 1)$, no contamination (baseline).
- `"leverage"` 10% of covariate values drawn from $U(5, 10)$ to introduce high-leverage points.
- `"robustness"` 10% of observations generated with the shape parameter shifted by -0.5 (alpha contamination).

`semente` Integer RNG seed for reproducibility (default `2023`).

Value

A numeric matrix of dimension 10×4. Columns are the four parameters `Beta0`, `Beta1`, `Alpha`, `Gama`; rows are: `Parametro` (true value), `EMV` (mean estimate), `VIES-ABS` (absolute bias), `VIES-REL` (relative bias), `VAR` (empirical variance), `EQM` (mean squared error), `E-PADRAO` (empirical standard error), `EP-FISHER` (mean Fisher standard error), `RAIZ-EQM` (root mean squared error), and `TAXA-COB` (empirical 95% coverage rate).

References

Ospina, R., Lima, J. I. C., Barros, M., and Macedo, A. M. S. (2026). Local influence diagnostics for the extreme-value Birnbaum-Saunders regression model. *Submitted*.

See Also

`revbs`, `evbsreg.fit`.

Examples

```
## Quick check with m = 50 replicates
res <- evbsreg.fit.mc(m = 50, n = 60,
                      beta0 = 0.5, beta1 = 0.5,
                      alpha = 0.5, gama = 0.20,
                      scenario = "canonical")
print(res)
```

evbs_block_boot — *Block bootstrap standard errors for the EVBS regression model*

Description

Nonparametric moving-block bootstrap for the parameters of the EVBS regression model. Intended for series with residual serial dependence, where the standard errors obtained from the observed information under the independence assumption are optimistic.

Usage

```
evbs_block_boot(X, y, L = 4, B = 500)
```

Arguments

`X`	Design matrix (including the intercept column).
`y`	Response vector.
`L`	Block length.
`B`	Number of bootstrap resamples.

Value

A list with the bootstrap standard errors and the matrix of bootstrap estimates.

Examples

```
data(itajai)
evbs_block_boot(cbind(1, itajai$pressure), itajai$wind, L = 4, B = 100)$se
```

evbs_endpoint — *Finite upper endpoint of the EVBS distribution*

Description

When $\gamma < 0$ the EVBS lies in the Weibull max-domain of attraction and its support is bounded above. The endpoint is the largest response the fitted model regards as possible, and is therefore the quantity of primary interest in design applications. It is also highly sensitive to individual observations, which is what the local influence diagnostics in this package are designed to detect.

Usage

```
evbs_endpoint(eta, alpha, gama)
```

Arguments

`eta`	Location on the log scale, typically $x^\top \beta$.
`alpha`	Positive shape (scale) parameter.
`gama`	Extreme-value shape parameter.

Value

The finite upper endpoint, or `Inf` when $\gamma \geq 0$.

Examples

```
evbs_endpoint(eta = 2.58, alpha = 0.19, gama = -0.16)
evbs_endpoint(eta = 2.58, alpha = 0.19, gama = 0.10) # Inf
```

`evbs_monitor` *Prospective endpoint-identifiability index*

Description

Computes the monitoring index F_t that combines the conformal normal curvature diagnostic with the finite upper endpoint of the fitted model. The index compares the support the model would infer without the observation flagged by the curvature against the largest response actually observed.

Usage

```
evbs_monitor(X, y, burn = 40, use = c("curvature", "max"))
```

Arguments

`X`	Design matrix (including the intercept column).
`y`	Response vector, in time order.
`burn`	Number of initial observations before the index is first computed.
`use`	Either `"curvature"` (default) or `"max"`.

Details

Let $j^*(t)$ be the observation with the largest aggregate contribution when the model is fitted to the first t records, and $y_{\max}(t)$ the largest response up to t. Then

$$F_t = \hat{T}^*_{(-j^*(t))}(t)/y_{\max}(t),$$

where $\hat{T}^*_{(-j^*)}$ is the endpoint estimated after deleting the flagged observation, evaluated at its covariate value.

Values below one indicate that the model fitted without the flagged observation assigns probability zero to a value that was in fact observed: the endpoint is then determined by a single record and should not be quoted as a design value. The control limit at one follows from the definition and is not a tuning constant.

Deleting the sample maximum instead of the flagged observation (`use = "max"`) lowers the endpoint essentially by construction and produces an index that signals almost everywhere; it is provided for comparison only.

Value

A data frame with the time index, the running maximum, the flagged observation, the fitted shape parameter and the index `F`.

Examples

```
data(itajai)
ct <- evbs_monitor(cbind(1, itajai$pressure), itajai$wind, burn = 40)
plot(ct$t, ct$F, type = "l"); abline(h = 1, lty = 2)
```

`evbs_return_level` *Return level and expected shortfall for the EVBS regression model*

Description

Computes the `period`-observation return level and, optionally, the conditional tail expectation (expected shortfall) at a given linear predictor value.

Usage

```
evbs_return_level(object, x, period, es = FALSE)
```

Arguments

`object`	An object of class `evbsreg` from `evbsreg.fit`.
`x`	Covariate vector (including the intercept) at which to evaluate.
`period`	Return period, expressed in the units of one observation. For monthly maxima and a T-year return level, use `period = 12 * T`.
`es`	Logical; if `TRUE`, also return the expected shortfall.

Value

A named numeric vector with the return level and, if requested, the expected shortfall.

Examples

```
data(itajai)
fit <- evbsreg.fit(cbind(1, itajai$pressure), itajai$wind)
# 50-year return level at mean pressure, from monthly maxima
evbs_return_level(fit, x = c(1, mean(itajai$pressure)),
                  period = 12 * 50, es = TRUE)
```

generate_evbs_data *Generate EVBS Density Values*

Description

Computes $(t, f(t))$ pairs of the Extreme-Value Birnbaum-Saunders (EVBS) density over its support, for given parameters.

Usage

```
generate_evbs_data(alpha, beta, gama)
```

Arguments

alpha	Shape parameter $\alpha > 0$.
beta	Scale parameter $\beta > 0$.
gama	Tail-shape parameter γ (real). The support is bounded below when $\gamma > 0$ and above when $\gamma < 0$.

Value

A `data.frame` with columns `t` (support points) and `y` (density values).

References

Ferreira, M., Gomes, M. I., and Leiva, V. (2012). On an extreme value version of the Birnbaum-Saunders distribution. *REVSTAT*, 10, 181–210.

See Also

`plot_evbs_alpha`, `generate_logevbs_data`.

Examples

```
d <- generate_evbs_data(alpha = 0.5, beta = 1, gama = 0.5)
plot(d$t, d$y, type = "l", xlab = "t", ylab = "f(t)")
```

generate_logevbs_data *Generate log-EVBS Density Values*

Description

Computes $(y, f(y))$ pairs of the log-EVBS density over its support, for given parameters.

Usage

```
generate_logevbs_data(alpha, eta, gama)
```

Arguments

alpha	Shape parameter $\alpha > 0$.
eta	Location parameter η (real).
gama	Tail-shape parameter γ (real).

Value

A `data.frame` with columns `y_vals` (support points) and `fdp` (density values).

References

Leiva, V., Ferreira, M., Gomes, M. I., and Lillo, C. (2016). Extreme value Birnbaum-Saunders regression models applied to environmental data. *Stochastic Environmental Research and Risk Assessment*, 30, 1045–1058.

See Also

`plot_logevbs_alpha`, `generate_evbs_data`.

Examples

```
d <- generate_logevbs_data(alpha = 1, eta = 0, gama = 0.5)
plot(d$y_vals, d$fdp, type = "l", xlab = "y", ylab = "f(y)")
```

gevreg.fit — *Maximum likelihood fit of the GEV regression model*

Description

Fits $Y_i \sim \text{GEV}(\mu_i, \sigma, \xi)$ with $\mu_i = x_i^\top \beta$ by maximum likelihood, using the analytic gradient and several starting values for the shape parameter.

Usage

```
gevreg.fit(X, y, xi_start = c(-0.2, -0.05, 0.05, 0.2))
```

Arguments

`X`	Design matrix (including the intercept column).
`y`	Response vector.
`xi_start`	Vector of starting values for the shape parameter.

Details

Centring the covariates is strongly recommended: the GEV likelihood is poorly conditioned when covariates are far from the origin, and an uncentred fit may fail to converge without any warning.

Value

A list with the estimates, the log-likelihood, the observed information (Hessian of the negative log-likelihood) and the convergence code.

Examples

```
data(itajai)
X <- cbind(1, itajai$pressure - mean(itajai$pressure))
gevreg.fit(X, itajai$wind)
```

gev_scores — *Individual score contributions for the GEV regression model*

Description

Returns the matrix whose ith row is the score vector of the ith observation, $s_i(\theta) = \partial \ell_i / \partial \theta$, for the generalized extreme-value regression model with linear location, $Y_i \sim \text{GEV}(\mu_i, \sigma, \xi)$ and $\mu_i = x_i^\top \beta$.

Usage

```
gev_scores(y, X, beta, sigma, xi)
```

Arguments

`y`	Response vector.
`X`	Design matrix (including the intercept column).
`beta`	Regression coefficients for the location parameter.
`sigma`	Positive scale parameter.
`xi`	Extreme-value shape parameter.

Details

This matrix is the key to generalizing local influence diagnostics beyond a single model class. Under the case-weight perturbation scheme the perturbed log-likelihood is $\ell(\theta \mid \omega) = \sum_i \omega_i \ell_i(\theta)$, so the perturbation matrix is

$$\Delta = \frac{\partial^2 \ell(\theta \mid \omega)}{\partial\theta\, \partial\omega^\top} = [\, s_1(\theta) \ \cdots \ s_n(\theta)\,],$$

evaluated at the maximum likelihood estimate. That is, Δ is simply the matrix of individual score contributions. This holds for *any* likelihood model, which is why the conformal normal curvature framework requires nothing beyond the score and the observed information.

With $z_i = (y_i - \mu_i)/\sigma$, $u_i = 1 + \xi z_i > 0$ and $w_i = u_i^{-1/\xi}$, the components are

$$\partial\ell_i/\partial\mu_i = (\xi + 1 - w_i)/(\sigma u_i),$$

$$\partial\ell_i/\partial\sigma = -1/\sigma + z_i(\xi + 1 - w_i)/(\sigma u_i),$$

$$\partial\ell_i/\partial\xi = \xi^{-2}(1 - w_i)\log u_i - (z_i/u_i)\{1 + (1 - w_i)/\xi\}.$$

Value

An $n \times (p + 2)$ matrix of individual score contributions.

Examples

```
data(itajai)
X <- cbind(1, itajai$pressure - mean(itajai$pressure))
fit <- gevreg.fit(X, itajai$wind)
S <- gev_scores(itajai$wind, X, fit$beta, fit$sigma, fit$xi)
colSums(S) # approximately zero at the MLE
```

`itajai` *Monthly Maximum Wind Gusts at Itajai, Brazil*

Description

Monthly maximum wind gust speed and the daily mean atmospheric pressure on the day of each maximum, recorded at INMET station A-868 (latitude $-26.95083°$, longitude $-48.76194°$) in Itajai, Santa Catarina, Brazil, from July 2010 to October 2020.

Usage

```
itajai
```

Format

A data frame with 124 rows and 3 variables:

month Integer index of the monthly observation (1 = July 2010, ..., 124 = October 2020).

wind Numeric. Monthly maximum wind gust speed (m/s).

pressure Numeric. Daily mean atmospheric pressure (mb) on the day of the monthly maximum.

Details

Observation 82 corresponds to the catastrophic event of April 26, 2017 (wind = 33.9 m/s), a severe cold front that struck the coast of Santa Catarina, with fatalities reported by local civil-defense authorities. This observation is identified as highly influential on the tail-shape parameter by the diagnostics implemented in this package.

Source

Instituto Nacional de Meteorologia (INMET), Brazil. Data access: https://www.inmet.gov.br/

References

Ospina, R., Lima, J. I. C., Barros, M., and Macedo, A. M. S. (2026). Local influence diagnostics for the extreme-value Birnbaum-Saunders regression model. *Submitted*.

Examples

```
data(itajai)
str(itajai)
plot(itajai$pressure, itajai$wind, pch = 16, col = "darkgreen",
     xlab = "Pressure (mb)", ylab = "Wind gust (m/s)")
```

---

logEVBS — *The log-EVBS distribution for GAMLSS models*

Description

Defines the log-Extreme-Value Birnbaum-Saunders distribution as a three-parameter **gamlss** family, so that each parameter may depend on covariates through a linear predictor or a smooth term. This is the natural way to let the tail-shape parameter vary with covariates, which the fixed three-parameter fit of `evbsreg.fit` does not allow.

Usage

```
logEVBS(mu.link = "identity", sigma.link = "log", nu.link = "identity")
```

Arguments

`mu.link`	Link for the location parameter μ (default `"identity"`; the predictor is on the log-response scale).
`sigma.link`	Link for the scale parameter $\alpha > 0$ (default `"log"`).
`nu.link`	Link for the extreme-value shape parameter γ (default `"identity"`).

Details

The response is $Y = \log T$ where T follows the EVBS distribution, so that $Z = (2/\sigma)\sinh\{(Y - \mu)/2\} \sim \mathrm{GEV}(0, 1, \nu)$. The parameter map is $\mu = \eta = x^\top\beta$ (identity link), $\sigma = \alpha$ (log link, positive) and $\nu = \gamma$ (identity link, real-valued).

With a constant predictor the fitted (μ, σ, ν) reproduce the (η, α, γ) of `evbsreg.fit`; this equivalence is the recommended check after loading the family. The score and second-order derivatives required by **gamlss** are obtained by automatic numerical differentiation of the analytic log-density, which is exact to working precision and avoids transcription error in the lengthy closed forms.

Value

A `gamlss.family` object.

Examples

```
## Not run:
  library(gamlss)
  data(itajai)
  y <- log(itajai$wind)
  # constant model: should match evbsreg.fit on the log scale
  m0 <- gamlss(y ~ 1, family = logEVBS())
  # tail shape depending on pressure:
  m1 <- gamlss(y ~ pressure, nu.formula = ~ pressure,
               data = itajai, family = logEVBS())

## End(Not run)
```

`pevbs` *Distribution function of the Extreme-Value Birnbaum-Saunders distribution*

Description

Distribution function of the Extreme-Value Birnbaum-Saunders distribution

Usage

```
pevbs(t, eta, alpha, gama, lower.tail = TRUE)
```

Arguments

`t`	Vector of positive quantiles.
`eta`	Location on the log scale, typically $x^\top \beta$.
`alpha`	Positive shape (scale) parameter.
`gama`	Extreme-value shape parameter.
`lower.tail`	Logical; if `TRUE` (default), probabilities are $P(T \leq t)$, otherwise $P(T > t)$.

Value

A numeric vector of probabilities.

Examples

```
pevbs(30, eta = 2.58, alpha = 0.19, gama = -0.16, lower.tail = FALSE)
```

`plot.evbs_monitor` *Plot an endpoint-identifiability control chart*

Description

Plot an endpoint-identifiability control chart

Usage

```
## S3 method for class 'evbs_monitor'
plot(x, ...)
```

Arguments

`x`	An object returned by `evbs_monitor`.
`...`	Further arguments passed to `plot`.

Value

Called for its side effect; invisibly returns `x`.

plot_aggregate_contributions *Plot Aggregate Contributions B_j(q)*

Description

Produces panel (b) of the diagnostic figure: the aggregate contributions $B_j(q)$ of each observation, with a horizontal reference line at $b(q)$ and automatic labelling of the most influential points.

Usage

```
plot_aggregate_contributions(
  diag,
  q = 7,
  label.flagged = 5,
  pch = 16,
  cex = 0.7,
  main = ""
)
```

Arguments

diag	A list returned by cnc_diagnostics.
q	Integer influence threshold in $1, \ldots, 7$. The paper uses q = 7.
label.flagged	Number of largest observations to label.
pch	Plotting character (default 16).
cex	Point size expansion (default 0.7).
main	Plot title (default empty).

Value

The indices of the labelled observations, returned invisibly. Also produces a base-graphics plot as a side effect.

See Also

plot_cnc, cnc_diagnostics.

Examples

```
data(itajai)
fit <- evbsreg.fit(cbind(1, itajai$pressure), itajai$wind)
diag <- cnc_diagnostics(fit)
plot_aggregate_contributions(diag, q = 7, main = "(b)")
```

plot_cnc — *Combined Conformal Normal Curvature Diagnostic Plot*

Description

Produces the two-panel diagnostic figure of the paper: normalized eigenvalues (left) and aggregate contributions $B_j(q)$ (right), side by side.

Usage

```
plot_cnc(diag, q = 7, label.flagged = 5)
```

Arguments

`diag`	A list returned by `cnc_diagnostics`.
`q`	Integer influence threshold in $1, \ldots, 7$ (default 7).
`label.flagged`	Number of largest observations to label in the right panel (default 5).

Value

Called for its side effect (a two-panel base-graphics figure). Returns `NULL` invisibly.

See Also

`cnc_diagnostics`, `plot_normalized_eigenvalues`, `plot_aggregate_contributions`.

Examples

```
data(itajai)
fit <- evbsreg.fit(cbind(1, itajai$pressure), itajai$wind)
diag <- cnc_diagnostics(fit)
plot_cnc(diag, q = 7)
```

plot_evbs_alpha — *Plot EVBS Densities for Varying alpha*

Description

Reproduces Figure 1(a) of the paper: EVBS densities for $\alpha \in \{0.25, 0.5, 0.75, 1\}$, $\beta = 1$, $\gamma = 0.5$. Uses **ggplot2** with the Dark2 colour palette.

Usage

```
plot_evbs_alpha()
```

Value

A `ggplot` object.

See Also

`plot_evbs_gama`, `generate_evbs_data`.

Examples

```
print(plot_evbs_alpha())
```

`plot_evbs_gama` *Plot EVBS Densities for Varying gamma*

Description

Reproduces Figure 1(b) of the paper: EVBS densities for $\gamma \in \{-1.25, -0.75, 0.75, 1.25\}$, $\alpha = 0.5$, $\beta = 1.5$. Uses **ggplot2** with the Dark2 colour palette.

Usage

```
plot_evbs_gama()
```

Value

A `ggplot` object.

See Also

`plot_evbs_alpha`.

Examples

```
print(plot_evbs_gama())
```

plot_logevbs_alpha — *Plot log-EVBS Densities for Varying alpha*

Description

Reproduces Figure 2(a) of the paper: log-EVBS densities for $\alpha \in \{0.25, 0.5, 2, 4\}$, $\eta = 0$, $\gamma = 0$. Uses **ggplot2** with the Dark2 colour palette.

Usage

```
plot_logevbs_alpha()
```

Value

A `ggplot` object.

See Also

`plot_logevbs_gama`.

Examples

```
print(plot_logevbs_alpha())
```

plot_logevbs_gama — *Plot log-EVBS Densities for Varying gamma*

Description

Reproduces Figure 2(b) of the paper: log-EVBS densities for $\gamma \in \{-1.05, -0.5, 0.5, 1.05\}$, $\alpha = 1$, $\eta = 0$. Uses **ggplot2** with the Dark2 colour palette.

Usage

```
plot_logevbs_gama()
```

Value

A `ggplot` object.

See Also

`plot_logevbs_alpha`.

Examples

```
print(plot_logevbs_gama())
```

`plot_normalized_eigenvalues`

Plot Normalized Eigenvalues of the Influence Matrix

Description

Produces panel (a) of the diagnostic figure: the normalized eigenvalues of the influence matrix, with horizontal reference thresholds for $q = 1, \dots, 7$.

Usage

```
plot_normalized_eigenvalues(diag, pch = 16, cex = 1, main = "")
```

Arguments

`diag`	A list returned by `cnc_diagnostics`.
`pch`	Plotting character (default `16`).
`cex`	Point size expansion (default `1`).
`main`	Plot title (default empty).

Value

Called for its side effect (a base-graphics plot). Returns `NULL` invisibly.

See Also

`plot_cnc`, `cnc_diagnostics`.

Examples

```
data(itajai)
fit <- evbsreg.fit(cbind(1, itajai$pressure), itajai$wind)
diag <- cnc_diagnostics(fit)
plot_normalized_eigenvalues(diag, main = "(a)")
```

print.evbsreg — *Print Method for EVBS Regression Fits*

Description

Compactly prints the parameter estimates, standard errors, and Wald tests of an object returned by `evbsreg.fit`.

Usage

```
## S3 method for class 'evbsreg'
print(x, digits = 4, ...)
```

Arguments

`x`	An object of class `"evbsreg"`.
`digits`	Number of significant digits (default 4).
`...`	Further arguments passed to `print.default`.

Value

The object `x`, invisibly. Called for the side effect of printing a coefficient table to the console.

See Also

`evbsreg.fit`.

Examples

```
data(itajai)
fit <- evbsreg.fit(cbind(1, itajai$pressure), itajai$wind)
print(fit)
```

qevbs — *Quantile function of the Extreme-Value Birnbaum-Saunders distribution*

Description

Exact quantile function on the response scale. This is the function needed to compute return levels; the generalized extreme-value return-level formula does **not** apply to the EVBS response, since the response is a monotone transformation of a GEV variate rather than a GEV variate itself.

Usage

```
qevbs(p, eta, alpha, gama)
```

Arguments

p	Vector of probabilities in $(0, 1)$.
eta	Location on the log scale, typically $x^\top \beta$.
alpha	Positive shape (scale) parameter.
gama	Extreme-value shape parameter.

Value

A numeric vector of quantiles.

Examples

```
# 50-year return level from monthly maxima: p = 1 - 1/(12*50)
qevbs(1 - 1 / 600, eta = 2.58, alpha = 0.19, gama = -0.16)
```

---

rcoxsnell *Cox-Snell Residuals for the Log-EVBS Regression Model*

Description

Computes Cox-Snell residuals for a log-EVBS regression fit. Under a correctly specified model these residuals form an approximately standard exponential sample.

Usage

```
rcoxsnell(X, t)
```

Arguments

X	A numeric design matrix with an intercept column.
t	A numeric vector of strictly positive responses.

Value

A numeric vector of length `length(t)` containing the Cox-Snell residuals.

References

Cox, D. R. and Snell, E. J. (1968). A general definition of residuals. *Journal of the Royal Statistical Society, Series B*, 30, 248–275.

See Also

rqrandomized, envelope_qq.

Examples

```
data(itajai)
X <- cbind(1, itajai$pressure)
cs <- rcoxsnell(X, itajai$wind)
summary(cs)
```

---

revbs *Random Number Generation from the EVBS Distribution*

Description

Generates random variates from the Extreme-Value Birnbaum-Saunders (EVBS) distribution by transforming Generalized Extreme Value (GEV) variates.

Usage

```
revbs(n, alpha, beta, gama)
```

Arguments

n	Sample size (number of variates to generate).
alpha	Shape parameter $\alpha > 0$.
beta	Scale parameter $\beta > 0$.
gama	Tail-shape parameter γ (real).

Details

If $Z \sim \mathrm{GEV}(0, 1, \gamma)$, then $T = \beta\{1 + \alpha^2 Z^2/2 + \alpha Z\sqrt{1 + \alpha^2 Z^2/4}\}$ follows the EVBS distribution. GEV variates are drawn via `rgev` from the **SpatialExtremes** package.

Value

A numeric vector of `n` EVBS variates. Returns `NA` if `n` is `NA`.

References

Ferreira, M., Gomes, M. I., and Leiva, V. (2012). On an extreme value version of the Birnbaum-Saunders distribution. *REVSTAT*, 10, 181–210.

See Also

`evbsreg.fit.mc`, `evbsreg.fit`.

Examples

```
set.seed(2023)
x <- revbs(100, alpha = 0.5, beta = 1, gama = 0.2)
summary(x)
```

`rqrandomized` *Randomized Quantile Residuals for the Log-EVBS Regression Model*

Description

Computes randomized quantile residuals (Dunn and Smyth, 1996) for a log-EVBS regression fit. Under a correctly specified model these residuals are approximately standard normal, so departures from normality indicate lack of fit.

Usage

```
rqrandomized(X, t)
```

Arguments

`X`	A numeric design matrix with an intercept column.
`t`	A numeric vector of strictly positive responses.

Value

A numeric vector of length `length(t)` containing the randomized quantile residuals.

References

Dunn, P. K. and Smyth, G. K. (1996). Randomized quantile residuals. *Journal of Computational and Graphical Statistics*, 5, 236–244.

See Also

`rcoxsnell`, `envelope_qq`, `evbsreg.fit`.

Examples

```
data(itajai)
X <- cbind(1, itajai$pressure)
r <- rqrandomized(X, itajai$wind)
shapiro.test(r)
```

Index