

Package ‘varGuidTS’

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Title Variance-Guided Time-Series Modeling for Temporal Risk Detection

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BugReports <https://github.com/zionwzz/variance-guided-risk-demo/issues>

Depends R (>= 4.1.0)

Imports stats, glmnet

Suggests testthat (>= 3.0.0)

Description Fits balanced-panel autoregressive models with conditional heteroscedasticity for temporal risk detection. The main estimator combines autoregressive exogenous mean modeling with GARCH-X variance modeling, subject-specific baseline terms, shared population coefficients, and L1 penalization for high-dimensional covariates. The package returns conditional mean and variance estimates, coefficient summaries, simulations, and exceedance-based risk scores defined as estimated conditional threshold-exceedance probabilities. The implementation builds on the lasso of Tibshirani (1996) <[doi:10.1111/j.2517-6161.1996.tb02080.x](https://doi.org/10.1111/j.2517-6161.1996.tb02080.x)>, generalized autoregressive conditional heteroscedasticity of Bollerslev (1986) <[doi:10.1016/0304-4076\(86\)90063-1](https://doi.org/10.1016/0304-4076(86)90063-1)>, and L1-regularized high-dimensional time-series modeling of Medeiros and Mendes (2016) <[doi:10.1016/j.jeconom.2015.10.011](https://doi.org/10.1016/j.jeconom.2015.10.011)>.

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varGuidTS-package	<i>varGuidTS: Variance-Guided Time-Series Modeling for Temporal Risk Detection</i>
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Description

Fits a balanced panel ARX-GARCHX model with subject-specific intercepts, shared population coefficients, and joint L1 penalization on the conditional mean and variance. Provides an exceedance-based risk score $\pi_{s,t}(c) = P(Y_{s,t} > c | F_{t-1})$ for personalized temporal risk assessment from wearable-sensor and other high-frequency panel time-series data.

Author(s)

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References

- Tibshirani R. (1996). "Regression Shrinkage and Selection Via the Lasso." *Journal of the Royal Statistical Society: Series B*, 58(1), 267–288. doi:[10.1111/j.25176161.1996.tb02080.x](https://doi.org/10.1111/j.25176161.1996.tb02080.x)
- Bollerslev T. (1986). "Generalized Autoregressive Conditional Heteroskedasticity." *Journal of Econometrics*, 31(3), 307–327. doi:[10.1016/03044076\(86\)900631](https://doi.org/10.1016/03044076(86)900631)
- Medeiros M. C. and Mendes E. F. (2016). "L1-Regularization of High-Dimensional Time-Series Models with Non-Gaussian and Heteroskedastic Errors." *Journal of Econometrics*, 191(1), 255–271. doi:[10.1016/j.jeconom.2015.10.011](https://doi.org/10.1016/j.jeconom.2015.10.011)

See Also

[lmvt](#), [predict.lmvt](#), [summary.lmvt](#), [simulate_scenario](#)

`coef.lmvt`*Extract or print coefficients from a fitted lmvt model*

Description

`coef()` returns the list of fitted parameter blocks (subject-specific intercepts, AR coefficients, mean covariate coefficients, baseline variances, ARCH/GARCH parameters, and variance covariate coefficients).

`print()` produces a one-screen summary of the fit.

Usage

```
## S3 method for class 'lmvt'  
coef(object, ...)  
## S3 method for class 'lmvt'  
print(x, ...)
```

Arguments

<code>object, x</code>	A fitted <code>lmvt</code> object.
<code>...</code>	Unused.

Value

For `coef.lmvt()`, a named list containing fitted coefficient blocks:

`alpha` subject-specific intercepts in the conditional mean model.

`theta` shared autoregressive coefficients for lagged responses.

`beta` shared coefficients for covariates in the conditional mean model.

`omega` subject-specific baseline variance parameters.

`a` shared ARCH coefficients for lagged squared residuals.

`b` shared GARCH coefficients for lagged conditional variances.

`gamma` shared coefficients for covariates in the conditional variance model.

For `print.lmvt()`, the fitted object `x` is returned invisibly after printing a short model summary.

See Also

[lmvt](#), [summary.lmvt](#)

lmvt

*Fit a penalized panel ARX-GARCH model***Description**

Joint maximum-quasi-likelihood fit of the conditional mean and variance across a balanced panel of subjects, with subject-specific intercepts, shared population coefficients, and L1 penalties on the mean and variance covariate vectors.

Usage

```
lmvt(data,
      p = 1, q = 0,
      r = 1, s_ord = 1,
      lambda_beta = 0,
      lambda_gamma = 0,
      maxit = 200, tol = 1e-4,
      standardize_X = TRUE,
      use_x_in_variance = TRUE,
      phi_cap = 0.995,
      omega_min = 1e-6,
      omega_cap_mult = 10,
      gamma_steps = 8,
      gamma_step = 1e-3,
      verbose = FALSE)
```

Arguments

data	A data frame containing columns <i>s</i> (subject ID), <i>t</i> (integer time), <i>y</i> (outcome), and any number of covariate columns.
p	Autoregressive order in the mean.
q	Distributed-lag order for covariates <i>x</i> .
r	ARCH order in the variance.
s_ord	GARCH order in the variance.
lambda_beta	L1 penalty for the mean covariate coefficients.
lambda_gamma	L1 penalty for the variance covariate coefficients.
maxit	Maximum number of outer block-coordinate iterations.
tol	Absolute tolerance on the QML objective for convergence.
standardize_X	Center and scale covariates before fitting.
use_x_in_variance	Include the lagged-X block in the variance equation.
phi_cap	Upper bound on $\sum a + \sum b$.
omega_min	Lower bound on subject-specific baseline variance.

omega_cap_mult	Multiplier on median(eps^2) used as the upper bound for ω_s in the L-BFGS-B update.
gamma_steps	Inner proximal-gradient steps for γ per outer iter.
gamma_step	Step size for the proximal-gradient update of γ .
verbose	Logical; print per-iteration diagnostics.

Value

An object of class "lmvt": a list with elements alpha, theta, beta, omega, a, b, gamma, ids, xcols, x_center, x_scale, orders, penalties, call, converged, iters, mean_times, var_times, iter_times.

References

- Tibshirani R. (1996). "Regression Shrinkage and Selection Via the Lasso." *Journal of the Royal Statistical Society: Series B*, 58(1), 267–288. doi:10.1111/j.25176161.1996.tb02080.x
- Bollerslev T. (1986). "Generalized Autoregressive Conditional Heteroskedasticity." *Journal of Econometrics*, 31(3), 307–327. doi:10.1016/03044076(86)900631
- Medeiros M. C. and Mendes E. F. (2016). "L1-Regularization of High-Dimensional Time-Series Models with Non-Gaussian and Heteroskedastic Errors." *Journal of Econometrics*, 191(1), 255–271. doi:10.1016/j.jeconom.2015.10.011

See Also

[predict.lmvt](#), [summary.lmvt](#), [simulate_scenario](#)

Examples

```
set.seed(1)
sim <- simulate_scenario(scen = 1, S = 5, T = 80, d_noise = 5,
                        noise_kind = "iid", seed = 1)
df <- sim[, c("s", "t", "y", grep("^X|^Noise|^Xbin",
                                names(sim), value = TRUE))]
fit <- lmvt(df, p = 1, q = 0, r = 1, s_ord = 1,
            lambda_beta = 0.05, lambda_gamma = 0.05)
print(fit)
```

predict.lmvt

Predict from a fitted lmvt object

Description

Computes the conditional mean $\hat{\mu}_{s,t}$, conditional standard deviation $\hat{\sigma}_{s,t}$, and the exceedance-based risk score $\hat{\pi}_{s,t}(c) = P(Y_{s,t} > c | F_{t-1})$ on a new (or held-out) panel data frame.

Usage

```
## S3 method for class 'lmvt'
predict(object, newdata, threshold = NULL,
        innov_g = TRUE, innov_t = FALSE, df_t = 6, ...)
```

Arguments

object	A fitted lmvt object.
newdata	A data frame containing columns s, t, y and the same covariate columns used during fitting.
threshold	Threshold c . Numeric scalar, vector of length <code>nrow(newdata)</code> , or per-subject vector. Defaults to the pooled 90th percentile of <code>newdata\$y</code> .
innov_g	Logical; return Gaussian-innovation exceedance probability <code>risk_g</code> .
innov_t	Logical; return Student-t-innovation exceedance probability <code>risk_t</code> .
df_t	Degrees of freedom for the Student-t innovation.
...	Unused, kept for S3 compatibility.

Value

A data frame with columns s, t, yhat = muhat, muhat, sigmahat, threshold_used, and one or both of risk_g, risk_t.

See Also

[lmvt](#), [summary.lmvt](#)

Examples

```
set.seed(1)
sim <- simulate_scenario(scen = 2, S = 4, T = 70, d_noise = 4,
                       noise_kind = "iid", seed = 1)
df <- sim[, c("s", "t", "y", grep("^X|^Noise|^Xbin",
                                names(sim), value = TRUE))]
fit <- lmvt(df, p = 1, q = 0, r = 1, s_ord = 1,
           lambda_beta = 0.05, lambda_gamma = 0.05, maxit = 8)

# 1) Pooled/global threshold: one cutoff is applied to every row.
pr_global <- predict(fit, df, threshold = stats::quantile(df$y, 0.90))
head(pr_global)

# 2) Subject-specific thresholds: use a named vector indexed by subject ID.
subject_cutoffs <- tapply(df$y, df$s, stats::quantile, probs = 0.75,
                          na.rm = TRUE)
pr_subject <- predict(fit, df, threshold = subject_cutoffs)
head(pr_subject)

# 3) Return both Gaussian and Student-t exceedance risk scores.
pr_t <- predict(fit, df, threshold = subject_cutoffs,
               innov_g = TRUE, innov_t = TRUE, df_t = 8)
```

```
head(pr_t[, c("s", "t", "muhat", "sigmahat", "risk_g", "risk_t")])
```

simulate_scenario	<i>Simulate a panel ARX-GARCHX dataset</i>
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Description

Simulates a balanced panel from one of four built-in demonstration scenarios. Returns a long-format data frame with the response y , oracle mean and variance, the covariate block, optional regime indicator, and the oracle exceedance probability.

Usage

```
simulate_scenario(scen = 1L, S = 8L, T = 240L, L = 20L,
                 d_noise = 20L, noise_kind = c("iid", "ar1"),
                 threshold_c = 1.0, seed = NULL,
                 floor_sigma2 = 1e-10)
```

Arguments

scen	Integer 1:4 selecting one of the four scenarios.
S	Number of subjects.
T	Number of post-burn-in time points per subject.
L	Mean run length for the piecewise regime in Scenario 4.
d_noise	Number of nuisance covariates with zero true effect.
noise_kind	Either "iid" or "ar1".
threshold_c	Threshold c at which the oracle exceedance probability is computed.
seed	Random seed.
floor_sigma2	Lower clamp on simulated variance.

Value

A data frame with columns s , t , y , oracle μ and σ , covariate columns, optional X_{bin} , and the oracle exceedance probability π_{true} . Generating parameters are stored in `attr(, "params")`.

References

- Tibshirani R. (1996). "Regression Shrinkage and Selection Via the Lasso." *Journal of the Royal Statistical Society: Series B*, 58(1), 267–288. doi:[10.1111/j.25176161.1996.tb02080.x](https://doi.org/10.1111/j.25176161.1996.tb02080.x)
- Bollerslev T. (1986). "Generalized Autoregressive Conditional Heteroskedasticity." *Journal of Econometrics*, 31(3), 307–327. doi:[10.1016/03044076\(86\)900631](https://doi.org/10.1016/03044076(86)900631)
- Medeiros M. C. and Mendes E. F. (2016). "L1-Regularization of High-Dimensional Time-Series Models with Non-Gaussian and Heteroskedastic Errors." *Journal of Econometrics*, 191(1), 255–271. doi:[10.1016/j.jeconom.2015.10.011](https://doi.org/10.1016/j.jeconom.2015.10.011)

Examples

```
set.seed(7)
sim <- simulate_scenario(scen = 2, S = 4, T = 50,
                        d_noise = 3, noise_kind = "iid", seed = 7)
head(sim)
```

summary.lmvt

Summarize a fitted lmvt object

Description

Produces model-level diagnostics and a coefficient summary table for a fitted penalized panel ARX-GARCHX model. The table includes subject-specific mean intercepts, autoregressive coefficients, mean covariate coefficients, subject-specific variance baselines, ARCH/GARCH coefficients, and variance covariate coefficients. Because `lmvt()` fits a penalized quasi-likelihood model, the table reports estimates and variable-selection indicators rather than classical standard errors or p-values.

Usage

```
## S3 method for class 'lmvt'
summary(object, tol = 1e-8, include_zero = TRUE,
        sort_by = c("block", "abs_estimate", "none"), top = NULL, ...)
```

Arguments

<code>object</code>	A fitted <code>lmvt</code> object.
<code>tol</code>	Absolute value used to flag a coefficient as selected/nonzero.
<code>include_zero</code>	Logical; if FALSE, return only coefficients with <code>abs(estimate) > tol</code> .
<code>sort_by</code>	Sorting rule for the coefficient table. Use "block" for model order, "abs_estimate" for decreasing absolute estimate, or "none" to keep construction order.
<code>top</code>	Optional positive integer limiting the returned coefficient table to the first top rows after filtering and sorting.
<code>...</code>	Unused, kept for S3 compatibility.

Value

`summary.lmvt()` returns an object of class "summary.lmvt", a list containing:

- `model`: model-level diagnostics;
- `nonzero`: counts of selected/nonzero coefficients by parameter block;
- `table`: the coefficient summary table after filtering/sorting;
- `full_table`: the complete coefficient table before filtering.

See Also

[lmvt](#), [coef.lmvt](#), [predict.lmvt](#)

Examples

```
set.seed(12)
sim <- simulate_scenario(scen = 1, S = 4, T = 60, d_noise = 4,
                        noise_kind = "iid", seed = 12)
df <- sim[, c("s", "t", "y", grep("^X|^Noise|^Xbin",
                                names(sim), value = TRUE))]
fit <- lmvt(df, p = 1, q = 0, r = 1, s_ord = 1,
            lambda_beta = 0.05, lambda_gamma = 0.05, maxit = 8)

# Printed summary
summary(fit)

# Programmatic coefficient table
sm <- summary(fit, include_zero = FALSE, sort_by = "abs_estimate")
sm$table
```

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