

# Package ‘mlVAR’

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**Type** Package

**Title** Multi-Level Vector Autoregression

**Version** 0.7.3

**Depends** R (>= 3.3.0)

**Imports** lme4, arm, qgraph, dplyr (>= 1.0.0), clusterGeneration,  
mvtnorm, corpcor, abind, methods, parallel, MplusAutomation,  
graphicalVAR, rlang

**Suggests** bootnet

**Maintainer** Sacha Epskamp <mail@sachaepskamp.com>

**Description** Estimates the multi-level vector autoregression model on time-series data.  
Three network structures are obtained: temporal networks, contemporaneous  
networks and between-subjects networks.

**License** GPL-2

**BugReports** <https://github.com/SachaEpskamp/mlVAR/issues>

**RoxygenNote** 7.3.3

**NeedsCompilation** no

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|        |                                 |
|--------|---------------------------------|
| getNet | <i>Gets a network structure</i> |
|--------|---------------------------------|

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**Description**

This function is simply a wrapper around the plotting method for mlVAR objects, that extracts the network structure rather than plotting them.

**Usage**

```
getNet(x, ...)
```

**Arguments**

- x                   An ‘mlVAR’ or ‘mlVARsim0’ object.
- ...                 Arguments sent to [plot.mlVAR](#)

**Author(s)**

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|             |                                 |
|-------------|---------------------------------|
| importMplus | <i>Import output from Mplus</i> |
|-------------|---------------------------------|

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**Description**

This function imports the output from an Mplus model that has been generated by mlVAR. It can be used to make manual changes to the input file.

**Usage**

```
importMplus(outfile)
```

**Arguments**

outfile                      Location of Mplus output file.

**Author(s)**

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mlGGM

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*Multi-Level Gaussian Graphical Model Estimation*


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**Description**

Estimates within-cluster and between-cluster partial correlation networks from cross-sectional multilevel data (e.g., individuals nested in classrooms, patients nested in clinics) using a single-step nodewise regression approach. Unlike `mlVAR`, which uses a two-step procedure (temporal model first, then contemporaneous), `mlGGM` fits all effects in a single multilevel model per variable. This makes it suitable for cross-sectional data where no temporal ordering exists.

For each variable  $y_i$ , a single mixed-effects model is fitted with within-cluster centered predictors and cluster-mean predictors. Two undirected networks (GGMs) are extracted: one capturing partial correlations at the within-cluster level (individual deviations from cluster means) and one at the between-cluster level (cluster means).

The same multi-level GGM can also be estimated with the `ml_ggm()` function of the `psychometrics` package. The two implementations use different estimators: `mlGGM` (this function) uses nodewise multilevel regression (one mixed-effects model per variable), while `psychometrics::ml_ggm` estimates the full two-level covariance structure by maximum likelihood, which additionally provides model fit indices and confirmatory model testing.

NOTE: This function is currently experimental and may change in future versions.

**Usage**

```
mlGGM(data, vars, idvar = "id",
       estimator = c("lmer"),
       randomeffects = c("default", "correlated", "orthogonal", "fixed"),
       scale = TRUE, na.rm = TRUE, verbose = TRUE,
       full_detrend = FALSE)

## S3 method for class 'mlGGM'
print(x, ...)
## S3 method for class 'mlGGM'
summary(object, show = c("fit", "within", "between"),
        round = 3, ...)
## S3 method for class 'mlGGM'
plot(x, type = c("within", "between"),
     partial = TRUE, SD = FALSE, subject, order,
     nonsig = c("default", "show", "hide", "dashed"),
     rule = c("or", "and"), alpha = 0.05,
     layout = "spring", verbose = TRUE, ...)
```

**Arguments**

|                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>data</code>          | A data frame containing the observed variables and a cluster identifier variable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <code>vars</code>          | A character vector of variable names to include in the GGM estimation. Must contain at least 2 variables.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <code>idvar</code>         | A string indicating the name of the cluster/group identifier variable in <code>data</code> . Defaults to <code>"id"</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <code>estimator</code>     | The estimator to be used. Currently only <code>"lmer"</code> (sequential univariate multi-level estimation via <a href="#">lmer</a> ) is supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <code>randomeffects</code> | How should random effects be estimated? <code>"correlated"</code> estimates correlated random slopes for within-cluster predictors (using <code>(1 + predictors   cluster)</code> ), <code>"orthogonal"</code> estimates uncorrelated random slopes (using <code>(1 + predictors    cluster)</code> ), and <code>"fixed"</code> estimates only a random intercept with no random slopes. <code>"default"</code> selects <code>"correlated"</code> when the number of variables is 6 or fewer and <code>"orthogonal"</code> otherwise, as correlated random effects become computationally expensive with many variables. |
| <code>scale</code>         | Logical. Should variables be grand-mean standardized before estimation? Defaults to <code>TRUE</code> . Standardization ensures that edge weights are comparable across variables.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <code>na.rm</code>         | Logical. Should rows with missing values be removed? Defaults to <code>TRUE</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <code>verbose</code>       | Logical indicating if console messages and progress bars should be shown.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <code>full_detrrend</code> | Logical. If <code>TRUE</code> , standardize each variable per observation position across all clusters before estimation. For example, all first observations within each cluster are standardized together, all second observations together, etc. Requires a balanced design (equal number of observations per cluster). Applied before grand-mean standardization ( <code>scale</code> ). Defaults to <code>FALSE</code> .                                                                                                                                                                                            |
| <code>x</code>             | An <code>mlGGM</code> object.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>object</code>        | An <code>mlGGM</code> object.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>show</code>          | Character vector indicating which sections to show in the summary. Options: <code>"fit"</code> for information criteria (AIC/BIC), <code>"within"</code> for within-cluster partial correlations and p-values, <code>"between"</code> for between-cluster partial correlations and p-values.                                                                                                                                                                                                                                                                                                                             |
| <code>round</code>         | Number of decimal places for rounding in the summary output. Defaults to 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <code>type</code>          | The type of network to plot or extract: <code>"within"</code> for the within-cluster partial correlation network, <code>"between"</code> for the between-cluster partial correlation network.                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>partial</code>       | Logical. If <code>TRUE</code> (default), plots partial correlations. If <code>FALSE</code> , plots zero-order correlations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <code>SD</code>            | Logical. If <code>TRUE</code> , plots random effect standard deviations instead of fixed effects. Only available for the within-cluster network.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <code>subject</code>       | Integer specifying which cluster's network to plot. Only available for the within-cluster network. When specified, the cluster-specific network (fixed effects + random effects for that cluster) is plotted.                                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>order</code>         | Character vector or numeric vector specifying the order of nodes in the plot.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

|        |                                                                                                                                                                                                                                                                                                  |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| nonsig | How to handle non-significant edges in the plot: "show" shows all edges regardless of significance, "hide" removes non-significant edges, "dashed" shows non-significant edges as dashed lines. "default" hides non-significant edges for partial correlation networks and shows them otherwise. |
| rule   | Significance rule for the undirected network: "or" requires at least one regression direction to be significant, "and" requires both directions to be significant. The "and" rule is more conservative and tends to improve specificity, especially for the between-cluster network.             |
| alpha  | Significance level for thresholding edges. Defaults to 0.05.                                                                                                                                                                                                                                     |
| layout | Layout algorithm for the network plot, passed to <a href="#">qgraph</a> . Defaults to "spring".                                                                                                                                                                                                  |
| ...    | Additional arguments passed to <a href="#">qgraph</a> (for plot) or ignored.                                                                                                                                                                                                                     |

## Details

mlGGM estimates multi-level Gaussian graphical models by fitting one mixed-effects regression model per variable. For each variable  $y_i$ , the model is:

$$y_i = \beta_0 + \sum_{j \neq i} \gamma_{ij}^{(w)} (y_j - \bar{y}_j) + \sum_{j \neq i} \gamma_{ij}^{(b)} \bar{y}_j + u_0 + \sum_{j \neq i} u_j (y_j - \bar{y}_j) + \varepsilon$$

where  $(y_j - \bar{y}_j)$  are within-cluster centered predictors and  $\bar{y}_j$  are cluster-mean predictors. The random effects  $u_0, u_j$  are placed on the intercept and within-cluster predictors only (not on between-cluster means).

Two GGMs are extracted using the relationship between nodewise regression coefficients and the precision matrix:

**Within-cluster network:** The precision matrix is computed as  $K_w = D_w(I - \Gamma_w)$ , where  $D_w = \text{diag}(1/\sigma_i^2)$  contains the inverse residual variances and  $\Gamma_w$  contains the fixed effects of the within-cluster centered predictors. The matrix is symmetrized and forced to be positive definite. Partial correlations are derived from the precision matrix.

**Between-cluster network:** The precision matrix is computed as  $K_b = D_b(I - \Gamma_b)$ , where  $D_b = \text{diag}(1/\mu_{SD,i}^2)$  contains the inverse squared random intercept standard deviations and  $\Gamma_b$  contains the fixed effects of the cluster-mean predictors.

**Cluster-specific networks:** When `randomeffects` is "correlated" or "orthogonal", cluster-specific within-cluster networks are also computed by adding the estimated random effects to the fixed effects for each cluster. These can be accessed via the `subject` argument in the `plot` method.

Network matrices can be extracted using `getNet` with `type = "within"` or `type = "between"`. The `rule` argument controls the significance thresholding rule.

## Value

An object of class "mlGGM" containing:

|         |                                                                                                                                                                                                                                      |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| results | A list with: <ul style="list-style-type: none"> <li>within: Within-cluster network estimates (covariance, correlation, partial correlation matrices, each with <code>\$mean</code> and <code>\$subject</code> components)</li> </ul> |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | <ul style="list-style-type: none"> <li>• <code>between</code>: Between-cluster network estimates (covariance, correlation, partial correlation matrices, with <code>\$mean</code> component)</li> <li>• <code>Gamma_within</code>: Within-cluster regression coefficients with <code>\$mean</code>, <code>\$SE</code>, <code>\$P</code>, and <code>\$subject</code> components</li> <li>• <code>Gamma_between</code>: Between-cluster regression coefficients with <code>\$mean</code>, <code>\$SE</code>, and <code>\$P</code> components</li> <li>• <code>mu</code>: Intercept estimates with <code>\$mean</code>, <code>\$SE</code>, and <code>\$SD</code> components</li> </ul> |
| <code>output</code> | A list of fitted <code>lmer</code> model objects, one per variable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <code>fit</code>    | A data frame with AIC and BIC for each variable's model.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>data</code>   | The augmented data frame used in estimation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <code>model</code>  | The predictor model specification data frame.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <code>input</code>  | A list of input arguments: <code>vars</code> , <code>estimator</code> , <code>randomeffects</code> , <code>idvar</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

### Author(s)

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### References

- Epskamp, S., Waldorp, L. J., Mottus, R., & Borsboom, D. (2018). The Gaussian graphical model in cross-sectional and time-series data. *Multivariate Behavioral Research*, 53(4), 453-480.
- Epskamp, S., Rhemtulla, M. T., & Borsboom, D. (2017). Generalized network psychometrics: Combining network and latent variable models. *Psychometrika*, 82(4), 904-927.

### See Also

`mlVAR` for multilevel VAR estimation with temporal data, `getNet` for extracting network matrices.

### Examples

```
## Not run:
# Generate simulated multilevel data with known GGM structure:
library(bootnet)

nNode <- 4
nCluster <- 30
clusterSize <- 50

# True within-cluster and between-cluster networks:
set.seed(1)
net_within <- genGGM(nNode, propPositive = 0.8)
net_between <- genGGM(nNode, p = 1, propPositive = 0.5)

# Generate within-cluster deviations:
within_data <- ggmGenerator()(nCluster * clusterSize, net_within)
within_data <- as.data.frame(within_data)
vars <- names(within_data)
within_data$cluster <- rep(1:nCluster, each = clusterSize)
```

```

# Generate between-cluster means:
between_data <- ggmGenerator()(nCluster, net_between)
between_data <- as.data.frame(between_data)
between_data$cluster <- 1:nCluster

# Combine: observed = within deviation + cluster mean
merged <- dplyr::left_join(within_data, between_data, by = "cluster",
                           suffix = c("_w", "_b"))
data <- merged[, grep("_w$", names(merged))] +
  merged[, grep("_b$", names(merged))]
names(data) <- vars
data$cluster <- merged$cluster

# Fit the multi-level GGM:
fit <- mlGGM(data, vars = vars, idvar = "cluster")

# Inspect results:
summary(fit)

# Plot within-cluster and between-cluster networks:
plot(fit, type = "within")
plot(fit, type = "between")

# Extract network matrices (with AND rule for better specificity):
within_net <- getNet(fit, "within", rule = "and")
between_net <- getNet(fit, "between", rule = "and")

## End(Not run)

```

## Description

The function `mIVAR` computes estimates of the multivariate vector autoregression model. This model returns three structures: temporal effects (e.g., lag-1 regression weights), contemporaneous relationships (correlations or partial correlations) and between-subject effects (correlations and partial correlations). See details.

The `predict` method computes fitted values and residuals from the temporal model (step 1). It returns predictions aligned to the original input data, with NA for rows that cannot be predicted (e.g., the first observation per person-day lost to lagging, or rows with missing data). When `newdata` is supplied, predictions are computed for the new data using the fitted model(s). For `estimator = "lmer"`, new subjects are predicted using fixed effects only (`allow.new.levels = TRUE`); for `estimator = "lm"`, prediction is only possible for subjects seen during training.

The `residuals` method is a convenience wrapper around `predict` that returns only the residuals.

The `resimulate` method generates simulated data from a fitted `mIVAR` model using person-specific estimated parameters (fixed + random effects). For each person, a VAR time series is simulated using their estimated temporal effects (Beta), contemporaneous precision matrix (Theta), and person-

specific means ( $\mu$ ). The output has the same dimensions and missingness pattern as the original input data, making it suitable for posterior predictive checks and model diagnostics.

### Usage

```
mlVAR(data, vars, idvar, lags = 1, dayvar, beepvar,
      estimator = c("default", "lmer", "lm", "Mplus"),
      contemporaneous = c("default", "correlated",
        "orthogonal", "fixed", "unique"), temporal =
      c("default", "correlated", "orthogonal", "fixed",
        "unique"), nCores = 1, verbose = TRUE, compareToLags,
      scale = TRUE, scaleWithin = FALSE, AR = FALSE,
      MplusSave = TRUE, MplusName = "mlVAR", iterations = "(2000)",
      chains = nCores, signs, orthogonal,
      trueMeans, na.rm = TRUE,
      full_detrend = FALSE
)

## S3 method for class 'mlVAR'
predict(object, newdata, scale_back = TRUE,
        include_ids = TRUE, ...)

## S3 method for class 'mlVAR'
residuals(object, scale_back = TRUE,
          include_ids = TRUE, ...)

resimulate(object, ...)

## S3 method for class 'mlVAR'
resimulate(object, scale_back = TRUE,
           include_ids = TRUE, nTime = NULL,
           keep_missing = TRUE,
           variance = c("model", "empirical"), ...)
```

### Arguments

|                      |                                                                                                                                                                                                                                                    |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>data</code>    | Data frame                                                                                                                                                                                                                                         |
| <code>vars</code>    | Vectors of variables to include in the analysis                                                                                                                                                                                                    |
| <code>idvar</code>   | String indicating the subject ID. This argument is required: multilevel estimation requires multiple subjects. For single-subject VAR estimation, see the <code>graphicalVAR</code> package.                                                       |
| <code>lags</code>    | Vector indicating the lags to include                                                                                                                                                                                                              |
| <code>dayvar</code>  | String indicating assessment day. Adding this argument makes sure that the first measurement of a day is not regressed on the last measurement of the previous day. <b>IMPORTANT:</b> only add this if the data has multiple observations per day. |
| <code>beepvar</code> | Optional string indicating assessment beep per day. Adding this argument will cause non-consecutive beeps to be treated as missing!                                                                                                                |

|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| estimator       | The estimator to be used. "lmer" for sequential univariate multi-level estimation, "Mplus" for multivariate Bayesian estimation (requires Mplus), and "lm" for fixed effects estimation.                                                                                                                                                                                                                                                                                                                                                                                        |
| contemporaneous | How should the contemporaneous networks be estimated? These networks are always estimated post-hoc by investigating the residuals of the temporal models. "correlated" and "orthogonal" run second multi-level models in which the networks are estimated using node-wise estimation. "fixed" and "unique" simply correlate the residuals, either by computing one network for all subjects (fixed) or a single network per per subject.                                                                                                                                        |
| temporal        | How should the temporal effects be estimated? "correlated" estimates correlated random effects, "orthogonal" estimates non-correlated random effects and "fixed" estimates a model in which only the intercept is random. Defaults to "correlated" when the number of variables is less than 6 and "orthogonal" otherwise. "unique" uses lm to estimate an unique model for each subject.                                                                                                                                                                                       |
| nCores          | Number of worker processes to use in computation. When greater than 1, this many parallel workers are spawned (previously one fewer worker than requested was used).                                                                                                                                                                                                                                                                                                                                                                                                            |
| verbose         | Logical indicating if console messages and the progress bar should be shown.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| scale           | Logical, should variables be standardized before estimation?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| scaleWithin     | Logical, should variables be scaled within-person (set to FALSE to only center within-person)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| compareToLags   | A vector indicating which lags to base the data on. If the model is to be compared with a model with multiple lags using <a href="#">mlVARcompare</a> , this argument must be used to make sure the number of observations is the same in both models (e.g., a lag 1 model can model the second observation of a day and a lag-2 model can't, causing different number of observations and incomparable models). It is suggested to not use this argument unless you want to compare models, and always run mlVAR without using this argument afterwards in the selected model. |
| AR              | Logical, should an auto-regression only model be fitted?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| MplusSave       | Logical, should the Mplus model file and output be saved?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| MplusName       | Name of the Mplus model file and output (without extensions)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| iterations      | The string used to define the number of iterations in Mplus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| chains          | Number of Mplus chains                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| signs           | Optional matrix fixing the signs of contemporaneous correlations. Is estimated by running mlVAR with estimator = "lmer" if missing.                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| orthogonal      | Deprecated argument only added for backward compatibility. Ignore.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| trueMeans       | Optional data frame with true person-wise means to use instead of estimated person means. Must contain the idvar column and all vars columns.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| na.rm           | Logical, should missing values be removed when checking for rank deficiency and when removing incomplete cases? Defaults to TRUE.                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| full_detrrend   | Logical. If TRUE, standardize each variable per observation position across all subjects before estimation. For example, all first measurements are standardized together, all second measurements together, etc. This removes systematic                                                                                                                                                                                                                                                                                                                                       |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | occasion effects (e.g., time-of-day trends in ESM data). Requires a balanced design (equal number of observations per subject). Applied before grand-mean standardization (scale). Defaults to FALSE.                                                                                                                                                                                                                                                                                                                                                                      |
| object       | An mlVAR object (for predict, residuals, and resimulate methods).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| newdata      | Optional data frame with the same structure as the training data. Must contain the idvar, dayvar, beepvar, and all vars columns. If supplied, predictions are computed for this new data using the fitted model. For estimator = "lmer", new subjects (not seen during training) receive fixed-effects-only predictions. For estimator = "lm", prediction is only available for subjects in the training data.                                                                                                                                                             |
| scale_back   | Logical. If TRUE (default) and the model was fitted with scale = TRUE, values are back-transformed to the original scale of the data. If FALSE, values are returned on the standardized (model) scale. Applies to predict, residuals, and resimulate.                                                                                                                                                                                                                                                                                                                      |
| include_ids  | Logical. If TRUE (default), the idvar, dayvar, and beepvar columns are prepended as columns in the returned data frame. Applies to predict, residuals, and resimulate. When nTime is specified in resimulate, only the idvar column is included.                                                                                                                                                                                                                                                                                                                           |
| nTime        | Optional integer specifying the number of time points to simulate per person. When NULL (default), the simulated data has the same number of rows as the original input data. When specified, each person gets exactly nTime time points, and the output has nIDs * nTime rows with the idvar and variable columns only (no dayvar or beepvar).                                                                                                                                                                                                                            |
| keep_missing | Logical. If TRUE (default) and nTime = NULL, the original variable-level missingness pattern is applied to the simulated data: any cell that was NA in the original data is set to NA in the output. If FALSE, all valid (non-structural-NA) positions receive simulated values. Ignored when nTime is specified.                                                                                                                                                                                                                                                          |
| variance     | Character string specifying how the innovation covariance matrix is obtained. "model" (default) uses the model-implied covariance derived from the estimated contemporaneous precision matrix (person-specific GGM structure, population-level residual scale). "empirical" uses the model's partial correlation structure (from the person-specific precision matrix) but scales it by the empirical standard deviations of each person's residuals, i.e., <code>SD %*% cov2cor(solve(kappa_i)) %*% SD</code> . Falls back to "model" for persons with too few residuals. |
| ...          | Additional arguments (currently unused).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

## Details

This function estimates the multi-level VAR model to obtain temporal, contemporaneous and between-subject effects using nodewise estimation. Temporal and between-subject effects are obtained directly from the models and contemporaneous effects are estimated post-hoc by correlating the residuals. See [arxiv.org/abs/1609.04156](https://arxiv.org/abs/1609.04156) for details.

Setting estimator = "Mplus" will generate a Mplus model, run the analysis and read the results into R. Mplus 8 is required for this estimation. It is recommended to set contemporaneous = "fixed", though not required. For the estimation of contemporaneous random effects, the signs of

contemporaneous \*correlations\* (not partial correlations) need be set (or estimated) via the `signs` argument.

The p-values reported for fixed effects (e.g., in `summary` and used to determine significance in `plot`) are Wald-type tests based on a normal approximation of the sampling distribution of each fixed-effect estimate (i.e.,  $2 * (1 - \text{pnorm}(\text{abs}(\text{estimate} / \text{SE})))$ ). This approximation is asymptotic and does not account for the uncertainty in the estimated degrees of freedom of the multilevel model. With few subjects the normal approximation can be anti-conservative (a t-distribution would be more appropriate), so these p-values should be treated as heuristic rather than exact, especially in small samples.

## Value

`mIVAR` returns an `mIVAR` object.

`predict.mIVAR` returns a data frame of predicted (fitted) values with the same number of rows as the original input data (or `newdata`). Rows that could not be predicted (e.g., first observation per person-day lost to lagging, or rows with missing data) contain NA. If `include_ids = TRUE`, the `idvar`, `dayvar`, and `beepvar` columns are prepended.

`residuals.mIVAR` returns a data frame of residuals with the same structure as `predict.mIVAR`.

`resimulate.mIVAR` returns a data frame of simulated values. By default (when `nTime = NULL`), it has the same number of rows as the original input data, with NAs in the same positions as the original data (unless `keep_missing = FALSE`). If `include_ids = TRUE`, the `idvar`, `dayvar`, and `beepvar` columns are prepended. When `nTime` is specified, the output has `nIDs * nTime` rows with the `idvar` column and variable columns only. Person-specific stationary means are computed from the model parameters, and innovation covariances are derived from the estimated contemporaneous precision matrices.

## Author(s)

Sacha Epskamp (mail@sachaepskamp.com)

## References

- Bringmann, L. F., Vissers, N., Wichers, M., Geschwind, N., Kuppens, P., Peeters, F., ... & Tuerlinckx, F. (2013). A network approach to psychopathology: New insights into clinical longitudinal data. *PloS one*, 8(4), e60188.
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- Epskamp, S., Waldorp, L. J., Mottus, R., & Borsboom, D. (2017). Discovering Psychological Dynamics: The Gaussian Graphical Model in Cross-sectional and Time-series Data. [arxiv.org/abs/1609.04156](https://arxiv.org/abs/1609.04156).

## See Also

[mIVARcompare](#), [summary.mIVAR](#), [plot.mIVAR](#), [mlGGM](#)

## Examples

```
## Not run:
### Small example ###
# Simulate data:
Model <- mlVARsim(nPerson = 50, nNode = 3, nTime = 50, lag=1)

# Estimate using correlated random effects:
fit1 <- mlVAR(Model$Data, vars = Model$vars, idvar = Model$idvar, lags = 1, temporal = "correlated")

# Print some pointers:
print(fit1)

# Summary of all parameter estimates:
summary(fit1)

# Compare temporal relationships:
layout(t(1:2))
plot(Model, "temporal", title = "True temporal relationships", layout = "circle")
plot(fit1, "temporal", title = "Estimated temporal relationships", layout = "circle")

# Compare contemporaneous partial correlations:
layout(t(1:2))
plot(Model, "contemporaneous", title = "True contemporaneous relationships",
      layout = "circle")
plot(fit1, "contemporaneous", title = "Estimated contemporaneous relationships",
      layout = "circle")

# Compare between-subjects partial correlations:
layout(t(1:2))
plot(Model, "between", title = "True between-subjects relationships", layout = "circle")
plot(fit1, "between", title = "Estimated between-subjects relationships",
      layout = "circle")

# Predictions and residuals (same number of rows as input data):
pred <- predict(fit1)
res <- residuals(fit1)
dim(pred)
dim(res)

# Resimulate data from the fitted model (posterior predictive check):
sim <- resimulate(fit1)
dim(sim) # same dimensions as original data

# Resimulate with custom time series length (e.g., longer series):
sim_long <- resimulate(fit1, nTime = 500)
dim(sim_long) # nIDs * 500 rows

# Resimulate without applying original missingness pattern:
sim_complete <- resimulate(fit1, keep_missing = FALSE)
sum(is.na(sim_complete)) # only structural NAs (day/beep boundaries)

# Resimulate with empirical innovation variances (model partial correlations,
```

```

# scaled by person-specific empirical residual SDs):
sim_emp <- resimulate(fit1, variance = "empirical")
dim(sim_emp)

# Run same model with non-correlated temporal relationships and fixed-effect model:
fit2 <- mlVAR(Model$Data, vars = Model$vars, idvar = Model$idvar, lags = 1,
  temporal = "orthogonal")
fit3 <- mlVAR(Model$Data, vars = Model$vars, idvar = Model$idvar, lags = 1,
  temporal = "fixed")

# Compare models:
mlVARcompare(fit1, fit2, fit3)

# Inspect true parameter correlation matrix:
Model$model$Omega$cor$mean
# Even though correlations are high, orthogonal model works well often!

### Large example ###
Model <- mlVARsim(nPerson = 100, nNode = 10, nTime = 100, lag=1)

# Correlated random effects no longer practical. Use orthogonal or fixed:
fit4 <- mlVAR(Model$Data, vars = Model$vars, idvar = Model$idvar, lags = 1,
  temporal = "orthogonal")
fit5 <- mlVAR(Model$Data, vars = Model$vars, idvar = Model$idvar, lags = 1,
  temporal = "fixed")

# Compare models:
mlVARcompare(fit4, fit5)

# Compare temporal relationships:
layout(t(1:2))
plot(Model, "temporal", title = "True temporal relationships", layout = "circle")
plot(fit4, "temporal", title = "Estimated temporal relationships", layout = "circle")

# Compare contemporaneous partial correlations:
layout(t(1:2))
plot(Model, "contemporaneous", title = "True contemporaneous relationships",
  layout = "circle")
plot(fit4, "contemporaneous", title = "Estimated contemporaneous relationships",
  layout = "circle")

# Compare between-subjects partial correlations:
layout(t(1:2))
plot(Model, "between", title = "True between-subjects relationships", layout = "circle")
plot(fit4, "between", title = "Estimated between-subjects relationships",
  layout = "circle")

## End(Not run)

```

---

**Description**

These functions return a table of the fixed and random effects.

FUNCTIONS ARE DEPRECATED AND WILL BE REMOVED SOON.

**Usage**

```
fixedEffects(object, digits = 5)
randomEffects(object, digits = 5)
```

**Arguments**

|        |                            |
|--------|----------------------------|
| object | A mlVAR object             |
| digits | Number of digits to output |

**Author(s)**

Sacha Epskamp (mail@sachaepskamp.com), Marie K. Deserno (m.k.deserno@uva.nl) and Laura F. Bringmann (laura.bringmann@ppw.kuleuven.be)

**Description**

The function mlVAR0 computes estimates of the multivariate vector autoregression model as introduced by Bringmann et al. (2013) which can be extended through treatment effects, covariates and pre- and post assessment effects.

FUNCTION IS DEPRECATED AND WILL BE REMOVED SOON.

**Usage**

```
mlVAR0(data, vars, idvar, lags = 1, dayvar, beepvar,
        periodvar, treatmentvar, covariates, timevar,
        maxTimeDiff, control = list(optimizer = "bobyqa"),
        verbose = TRUE, orthogonal, estimator = c("lmer",
        "lmmlasso"), method = c("default", "stepwise",
        "movingWindow"), laginteractions = c("none", "mains",
        "interactions"), critFun = BIC, lambda = 0,
        center = c("inSubject", "general", "none"))
```

**Arguments**

|                 |                                                                                                                                                                                                                                                                                                                                       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| data            | Data frame                                                                                                                                                                                                                                                                                                                            |
| vars            | Vectors of variables to include in the analysis                                                                                                                                                                                                                                                                                       |
| idvar           | String indicating the subject ID                                                                                                                                                                                                                                                                                                      |
| lags            | Vector indicating the lags to include                                                                                                                                                                                                                                                                                                 |
| dayvar          | String indicating assessment day (if missing, every assessment is set to one day)                                                                                                                                                                                                                                                     |
| beepvar         | String indicating assessment beep per day (if missing, is added)                                                                                                                                                                                                                                                                      |
| periodvar       | String indicating the period (baseline, treatment period, etc.) of assessment (if missing, every assessment is set to one period)                                                                                                                                                                                                     |
| treatmentvar    | Character vector indicating treatment                                                                                                                                                                                                                                                                                                 |
| covariates      | Character indicating covariates independent of assessment.                                                                                                                                                                                                                                                                            |
| timevar         | Character indicating the time variable                                                                                                                                                                                                                                                                                                |
| maxTimeDiff     | Maximum time difference to include observation pairs                                                                                                                                                                                                                                                                                  |
| control         | A list of arguments sent to <a href="#">lmerControl</a>                                                                                                                                                                                                                                                                               |
| verbose         | Logical to print progress to the console                                                                                                                                                                                                                                                                                              |
| orthogonal      | Logical to indicate if orthogonal estimation (no correlated random effects) should be used. Defaults to FALSE if the number of nodes is less than 6 and TRUE otherwise                                                                                                                                                                |
| estimator       | Estimator to use. Note: <code>lmmlasso</code> implementation is very experimental                                                                                                                                                                                                                                                     |
| method          | Method to use. Experimental                                                                                                                                                                                                                                                                                                           |
| laginteractions | Experimental, do not use.                                                                                                                                                                                                                                                                                                             |
| critFun         | Experimental, do not use.                                                                                                                                                                                                                                                                                                             |
| lambda          | <code>lmmlasso</code> lambda parameter                                                                                                                                                                                                                                                                                                |
| center          | Centering to be used. "inSubject" uses within-person centering, "general" uses grand-mean centering and "none" does not use centering. <b>IMPORTANT NOTE:</b> "inSubject" leads to coefficients to resemble within-person slopes, the other centering option leads to coefficients to be a blend of within and between person slopes. |

**Details**

mIVAR0 has been built to extract individual network dynamics by estimating a multilevel vector autoregression model that models the time dynamics of selected variables both within an individual and on group level. For example, in a lag-1-model each variable at time point  $t$  is regressed to a lagged version of itself at time point  $t-1$  and all other variables at time point  $t-1$ . In psychological research, for example, this analysis can be used to relate the dynamics of symptoms on one day (as assessed by experience sampling methods) to the dynamics of these symptoms on the consecutive day.

**Value**

mlVAR0 returns a 'mlVAR0' object containing

|                                    |                                                                                                                                         |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <code>fixedEffects</code>          | A matrix that contains all fixed effects coefficients with dependent variables as rows and the lagged independent variables as columns. |
| <code>se.fixedEffects</code>       | A matrix that contains all standard errors of the fixed effects.                                                                        |
| <code>randomEffects</code>         | A list of matrices that contain the random effects coefficients.                                                                        |
| <code>randomEffectsVariance</code> | A matrix containing the estimated variances between the random-effects terms                                                            |
| <code>pvals</code>                 | A matrix that contains p-values for all fixed effects.                                                                                  |
| <code>pseudologlik</code>          | The pseudo log-likelihood.                                                                                                              |
| <code>BIC</code>                   | Bayesian Information Criterion, i.e. the sum of all univariate models' BICs                                                             |
| <code>input</code>                 | List containing the names of variables used in the analysis                                                                             |

**Author(s)**

Sacha Epskamp (mail@sachaepskamp.com), Marie K. Deserno (m.k.deserno@uva.nl) and Laura F. Bringmann (laura.bringmann@ppw.kuleuven.be)

**References**

Bringmann, L. F., Vissers, N., Wichers, M., Geschwind, N., Kuppens, P., Peeters, F., ... & Tuerlinckx, F. (2013). A network approach to psychopathology: New insights into clinical longitudinal data. *PloS one*, 8(4), e60188.

**See Also**

[fixedEffects](#), [fixedEffects](#)

**Examples**

```
## Not run:
### Small network ###
nVar <- 3
nPerson <- 25
nTime <- 25

# Simulate model and data:
Model <- mlVARsim(nPerson, nVar, nTime, beta_sparsity = 0.5)

# Run mlVAR0 (deprecated; see mlVAR() for the current implementation):
Res <- mlVAR0(Model$Data, vars = Model$vars, idvar = Model$idvar)

# Compare true temporal model with significant edges of the estimated model.
# Note that the simulated model is plotted by plot.mlVAR, which uses
# type = "temporal", while plot.mlVAR0 still uses the older type names
# ("fixed", "SD" and "subject"):
layout(t(1:2))
```

```

plot(Model, "temporal", title = "True model", layout = "circle", edge.labels = TRUE)
plot(Res, "fixed", title = "Estimated model", layout = "circle", onlySig = TRUE,
     alpha = 0.05, edge.labels = TRUE)

# Compare temporal networks of subject 1:
layout(t(1:2))
plot(Model, "temporal", subject = 1, title = "True model", layout = "circle",
     edge.labels = TRUE)
plot(Res, "subject", subject = 1, title = "Estimated model", layout = "circle",
     edge.labels = TRUE)

## End(Not run)

```

---

mIVAR0-methods

*print and summary functions for mIVAR0 objects*


---

## Description

Create a short summary of an object created by [mIVAR0](#).

FUNCTION IS DEPRECATED AND WILL BE REMOVED SOON.

## Usage

```

## S3 method for class 'mIVAR0'
print(x, ...)
## S3 method for class 'mIVAR0'
summary(object, ...)

```

## Arguments

|        |                   |
|--------|-------------------|
| object | A "mIVAR0" object |
| x      | A "mIVAR0" object |
| ...    | Not used          |

## Author(s)

Sacha Epskamp ([mail@sachaepskamp.com](mailto:mail@sachaepskamp.com)), Marie K. Deserno ([m.k.deserno@uva.nl](mailto:m.k.deserno@uva.nl)) and Laura F. Bringmann ([laura.bringmann@ppw.kuleuven.be](mailto:laura.bringmann@ppw.kuleuven.be))

mlVARcompare

*Compare mlVAR model fit*

---

**Description**

This function compares the fit of several mlVAR models. Since an mlVAR model is a combination of univariate models this function will compare the fits for each univariate model.

**Usage**

```
mlVARcompare(...)
```

**Arguments**

... Any number of objects obtained from [mlVAR](#)

**Details**

Important to note is that the number of observations must be equal to make models comparable. If the lags are different and `compareToLags` was not used in `mlVAR` this function will stop with an informative error message.

**Author(s)**

Sacha Epskamp (mail@sachaepskamp.com)

**Examples**

```
## Not run:
### Small example ###
# Simulate data:
Model <- mlVARsim(nPerson = 50, nNode = 3, nTime = 50, lag=1)

# Estimate using different methods:
fit1 <- mlVAR(Model$Data, vars = Model$vars, idvar = Model$idvar, lags = 1,
  temporal = "correlated")
fit2 <- mlVAR(Model$Data, vars = Model$vars, idvar = Model$idvar, lags = 1,
  temporal = "orthogonal")
fit3 <- mlVAR(Model$Data, vars = Model$vars, idvar = Model$idvar, lags = 1,
  temporal = "fixed")

# Compare models:
mlVARcompare(fit1,fit2,fit3)

## End(Not run)
```

mlVARsample

*Simulator function given an mlVAR object***Description**

Simulates data based on an mlVAR object, estimates the mlVAR network model based on the simulated data and compares the estimated network to the mlVAR object network.

**Usage**

```
mlVARsample(object, nTime = c(25,50,100,200), nSample = 100, pMissing = 0,
  nReps = 100, nCores = 1, ...)
```

```
## S3 method for class 'mlVARsample'
summary(object, ...)
```

**Arguments**

|          |                                                                                                                                                                                                                                      |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| object   | mlVAR object, or mlVARsample object in the summary method                                                                                                                                                                            |
| nTime    | Vector with number of time points to test.                                                                                                                                                                                           |
| nSample  | Number of individuals in the dataset. It is possible to decrease the number of individuals compared to the individuals in the mlVAR object. However, it is not possible to have more individuals than there are in the mlVAR object. |
| pMissing | Percentage of missing data to be simulated.                                                                                                                                                                                          |
| nReps    | Number of repetitions for each condition.                                                                                                                                                                                            |
| nCores   | Number of cores to use.                                                                                                                                                                                                              |
| ...      | Arguments sent to mlVAR.                                                                                                                                                                                                             |

**Details**

This function simulates data based on the mlVAR object. The individual networks (random effects) are used to simulate data using the `graphicalVARsim` function from the `graphicalVAR` package (Epskamp, 2020). The individual data is combined into one dataset. This dataset is used to estimate the mlVAR network.

For every condition, the function returns four values per network comparison measure (correlation, sensitivity, specificity, bias, and precision): one for the fixed temporal effects, one for the fixed contemporaneous effects, the mean comparison value of the random temporal effects, and the mean comparison value of the random contemporaneous effects.

**Author(s)**

Sacha Epskamp <mail@sachaepskamp.com>

## References

Sacha Epskamp (2020). graphicalVAR: Graphical VAR for Experience Sampling Data. R package version 0.2.3. <https://CRAN.R-project.org/package=graphicalVAR>

## See Also

[mlVARsim](#), [mlVAR](#)

## Examples

```
## Not run:
### Small example ###
# Simulate data:
Model <- mlVARsim(nPerson = 100, nNode = 3, nTime = 50, lag=1)

# Estimate using correlated random effects:
fit <- mlVAR(Model$Data, vars = Model$vars,
             idvar = Model$idvar, lags = 1,
             temporal = "correlated")

# Sample from fitted model:
samples <- mlVARsample(fit, nTime = 50, nSample = 50, pMissing = 0.1,
                      nReps = 5, nCores = 1)

# Summarize results:
summary(samples)

## End(Not run)
```

---

mlVARsim

*Simulates an mlVAR model and data*


---

## Description

Simulates an mlVAR model and data with a random variance-covariance matrix for the random effects.

## Usage

```
mlVARsim(nPerson = 10, nNode = 5, nTime = 100, lag = 1, thetaVar = rep(1,nNode),
DF_theta = nNode * 2, mu_SD = c(1, 1), init_beta_SD = c(0.1, 1), fixedMuSD = 1,
shrink_fixed = 0.9, shrink_deviation = 0.9, beta_sparsity = 0.5, pcor_sparsity = 0.5,
maxAbsValue = 100)
```

**Arguments**

|                  |                                                                                                                                                      |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| nPerson          | Number of subjects                                                                                                                                   |
| nNode            | Number of variables                                                                                                                                  |
| nTime            | Number of observations per person                                                                                                                    |
| lag              | The maximum lag to be used                                                                                                                           |
| thetaVar         | Contemporaneous fixed effect variances                                                                                                               |
| DF_theta         | Degrees of freedom in simulating person-specific contemporaneous covariances (e.g., the individual differences in contemporaneous effects)           |
| mu_SD            | Range of standard deviation for the means                                                                                                            |
| init_beta_SD     | Initial range of standard deviations for the temporal effects                                                                                        |
| fixedMuSD        | Standard deviation used in sampling the fixed effects                                                                                                |
| shrink_fixed     | Shrinkage factor for shrinking the fixed effects if the VAR model is not stationary                                                                  |
| shrink_deviation | Shrinkage factor for shrinking the random effects variance if the VAR model is not stationary                                                        |
| beta_sparsity    | Proportion of edges in the temporal network that are set to zero                                                                                     |
| pcor_sparsity    | Proportion of edges in the contemporaneous network that are set to zero                                                                              |
| maxAbsValue      | Maximum absolute value allowed in the generated data; if any simulated value exceeds this, the random effects are shrunk and the data is regenerated |

**Author(s)**

Sacha Epskamp (mail@sachaepskamp.com)

---

plot.mlVAR

---

*Plot Method for mlVAR*

---

**Description**

The function `plot.mlVAR` plots estimated model coefficients as networks using `qgraph`. These can be three networks: temporal, contemporaneous and between-subjects effects, of which the latter two can be plotted as a correlation or a partial correlation network.

**Usage**

```
## S3 method for class 'mlVAR'
plot(x, type = c("temporal", "contemporaneous", "between"),
      lag = 1, partial = TRUE, SD = FALSE, subject, order,
      nonsig = c("default", "show", "hide", "dashed"), rule
      = c("or", "and"), alpha = 0.05, onlySig = FALSE,
      layout = "spring", verbose = TRUE, ...)
## S3 method for class 'mlVARsim'
plot(x, ...)
```

**Arguments**

|         |                                                                                                                                                                                                                                                  |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x       | An mlVAR object.                                                                                                                                                                                                                                 |
| type    | What network to plot?                                                                                                                                                                                                                            |
| lag     | The lag to use when type = "temporal"                                                                                                                                                                                                            |
| partial | Logical, should partial correlation matrices be plotted instead of correlation methods? Only used if type is "contemporaneous" or "between". Defaults to TRUE.                                                                                   |
| SD      | Logical. Plot the standard-deviation of random effects instead of the fixed effect estimate?                                                                                                                                                     |
| subject | Subject number. If not missing, will plot the network of a specific subject instead.                                                                                                                                                             |
| order   | An optional character vector used to set the order of nodes in the network.                                                                                                                                                                      |
| nonsig  | How to handle non-significant edges? Default will hide non-significant edges when p-values are available (fixed effects, partial correlations and temporal effects).                                                                             |
| rule    | How to choose significance in node-wise estimated GGMs (contemporaneous and between-subjects). "or" selects an edge as being significant if one node predicting the other is significant, and "and" requires both predictions to be significant. |
| alpha   | Alpha level to test for significance                                                                                                                                                                                                             |
| onlySig | Deprecated argument only used for backward compatibility.                                                                                                                                                                                        |
| layout  | The layout argument used by <a href="#">qgraph</a>                                                                                                                                                                                               |
| verbose | Logical, should message be printed to the console?                                                                                                                                                                                               |
| ...     | Arguments sent to <a href="#">qgraph</a>                                                                                                                                                                                                         |

**Author(s)**

Sacha Epskamp (mail@sachaepskamp.com)

---

plot.mlVAR0

*Plot Method for mlVAR0*


---

**Description**

The function plot.mlVAR0 plots estimated model coefficients as a network using qgraph.

FUNCTION IS DEPRECATED AND WILL BE REMOVED SOON.

**Usage**

```
## S3 method for class 'mlVAR0'
plot(x, type = c("fixed", "SD", "subject"), lag = 1,
      subject, order, onlySig = FALSE, alpha, ...)
```

**Arguments**

|         |                                                                                                                                                                                                       |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x       | A mlVAR0 object obtained through the <a href="#">mlVAR0</a> -function                                                                                                                                 |
| type    | Indicates whether to plot a network of fixed effects coefficients ("fixed"), the standard deviations of the random effect terms ("SD") or an individual subject's random effects network ("subject"). |
| lag     | Vector indicating the lags to include                                                                                                                                                                 |
| subject | If type="subject", vector indicating the ID subject number                                                                                                                                            |
| order   | Order of nodes                                                                                                                                                                                        |
| onlySig | Logical. Set to TRUE to only plot significant fixed effects.                                                                                                                                          |
| alpha   | Significance level to test edges at if onlySig == TRUE. Defaults to Bonferonni corrected alpha level of 0.05 divided by the number of fixed effects.                                                  |
| ...     | Arguments sent to <a href="#">qgraph</a>                                                                                                                                                              |

**Author(s)**

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---

simulateVAR

*Simulate data from VAR model*


---

**Description**

Simulates a timeseries using VAR parameters

**Usage**

```
simulateVAR(pars, means = 0, lags = 1, Nt = 100, init, residuals = 0.1,
            burnin)
```

**Arguments**

|           |                                                                                                                                                                                                                                             |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| pars      | A square matrix or a list of square matrices indicating the VAR parameters                                                                                                                                                                  |
| means     | A vector of means.                                                                                                                                                                                                                          |
| lags      | The lags to which the 'pars' argument parameters correspond. If 'pars' is a list then this argument should be a vector indicating which lags are represented by each element of the 'pars' list.                                            |
| Nt        | Number of time points                                                                                                                                                                                                                       |
| init      | Initial setup. Must be a matrix of the first lags with rows corresponding to time points and columns corresponding to variables (e.g., if only two lags are used then the matrix must have two rows indicating the first two times points.) |
| residuals | Standard deviation of the residuals or a residual covariance matrix                                                                                                                                                                         |
| burnin    | Initial simulations not returned. Defaults to $\min(\text{round}(Nt/2), 100)$ .                                                                                                                                                             |

**Author(s)**

Sacha Epskamp (mail@sachaepskamp.com), Marie K. Deserno (m.k.deserno@uva.nl) and Laura F. Bringmann (laura.bringmann@ppw.kuleuven.be)

---

summary.mlVAR

*Summary of mlVAR results*


---

**Description**

Prints tables with fit indices and parameter estimates.

**Usage**

```
## S3 method for class 'mlVAR'
summary(object, show = c("fit", "temporal", "contemporaneous", "between"),
        round = 3, ...)
## S3 method for class 'mlVAR'
print(x, ...)
```

**Arguments**

|        |                       |
|--------|-----------------------|
| object | An mlVAR object.      |
| show   | Which tables to show? |
| round  | Number of digits.     |
| x      | An mlVAR object.      |
| ...    | Not used              |

**Author(s)**

Sacha Epskamp (mail@sachaepskamp.com), Marie K. Deserno (m.k.deserno@uva.nl) and Laura F. Bringmann (laura.bringmann@ppw.kuleuven.be)

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