Package ‘MVLM’

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Description Allows a user to conduct multivariate multiple regression using analytic p-values rather than classic approximate F-tests.
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Description

The MVLM package is used to fit linear models with a multivariate outcome. It utilizes the asymptotic null distribution of the multivariate linear model test statistic to compute p-values (McArtor et al., under review). It therefore alleviates the need to use approximate p-values based Wilks Lambda, Pillai’s Trace, the Hotelling-Lawley Trace, and Roy’s Greatest Root.

Usage

To access this package’s tutorial, type the following line into the console:

vignette("mvlm-vignette")

There is one primary function that comprises this package: vignette('mvlm-vignette') There is one primary function that comprise this package: mvlm, which regresses a multivariate outcome onto a set of predictors. Standard functions like summary, fitted, residuals, and predict can be called on a mvlm output object.

References


Examples

data(mvlmdata)
Y <- as.matrix(Y.mvlm)
mvlm.res <- mvlm(Y ~ Cont + Cat + Ord, data = X.mvlm)
summary(mvlm.res)
fitted.mvlm

Extract mvlm Fitted Values

Description

fitted method for class mvlm.

Usage

```r
# S3 method for class 'mvlm'
fitted(object, ...)
```

Arguments

- `object`: Output from mvlm
- `...`: Further arguments passed to or from other methods.

Value

A data frame of fitted values with the same dimension as the outcome data passed to mvlm

Author(s)

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Examples

```r
data(mvlmdata)
Y <- as.matrix(Y.mvlm)
mvlm.res <- mvlm(Y ~ Cont + Cat + Ord, data = X.mvlm)
Y.hat <- fitted(mvlm.res)
```

mvlm

Conduct multivariate multiple regression and MANOVA with analytic p-values

Description

mvlm is used to fit linear models with a multivariate outcome. It uses the asymptotic null distribution of the multivariate linear model test statistic to compute p-values (McArtor et al., under review). It therefore alleviates the need to use approximate p-values based Wilks’ Lambda, Pillai’s Trace, the Hotelling-Lawley Trace, and Roy’s Greatest Root.
Usage

\texttt{mvlm(formula, data, n.cores = 1, start.acc = 1e-20, contr.factor = "contr.sum", contr.ordered = "contr.poly")}

Arguments

\begin{itemize}
  \item \texttt{formula} An object of class \texttt{formula} where the outcome (e.g. the \texttt{Y} in the following formula: \texttt{Y \sim x1 + x2}) is a \textit{n x q} matrix, where \textit{q} is the number of outcome variables being regressed onto the set of predictors included in the formula.
  \item \texttt{data} Mandatory \texttt{data.frame} containing all of the predictors passed to \texttt{formula}.
  \item \texttt{n.cores} Number of cores to use in parallelization through the \texttt{parallel} package.
  \item \texttt{start.acc} Starting accuracy of the Davies (1980) algorithm implemented in the \texttt{davies} function in the \texttt{CompQuadForm} package (Duchesne & De Micheaux, 2010) that \texttt{mvlm} uses to compute multivariate linear model p-values.
  \item \texttt{contr.factor} The type of contrasts used to test unordered categorical variables that have type \texttt{factor}. Must be a string taking one of the following values: \texttt{"contr.sum"}, \texttt{"contr.treatment"}, \texttt{"contr.helmert"}.
  \item \texttt{contr.ordered} The type of contrasts used to test ordered categorical variables that have type \texttt{ordered}. Must be a string taking one of the following values: \texttt{"contr.poly"}, \texttt{"contr.sum"}, \texttt{"contr.treatment"}, \texttt{"contr.helmert"}.
\end{itemize}

Details

Importantly, the outcome of \texttt{formula} must be a matrix, and the object passed to \texttt{data} must be a \texttt{data.frame} containing all of the variables that are named as predictors in \texttt{formula}.

The conditional effects of variables of type \texttt{factor} or \texttt{ordered} in \texttt{data} are computed based on the type of contrasts specified by \texttt{contr.factor} and \texttt{contr.ordered}. If \texttt{data} contains an (ordered or unordered) factor with \textit{k} levels, a \textit{k-1} degree of freedom test will be conducted corresponding to that factor and the specified contrast structure. If, instead, the user wants to assess \textit{k-1} separate single DF tests that comprise this omnibus effect (similar to the approach taken by \texttt{lm}), then the appropriate model matrix should be formed in advance and passed to \texttt{mvlm} directly in the \texttt{data} parameter. See the package \texttt{vignette} for an example by calling \texttt{vignette(mvlm-vignette')}.

Value

An object with nine elements and a summary function. Calling \texttt{summary(mvlm.res)} produces a \texttt{data.frame} comprised of:

\begin{itemize}
  \item \texttt{Statistic} Value of the corresponding test statistic.
  \item \texttt{Numer DF} Numerator degrees of freedom for each test statistic.
  \item \texttt{Pseudo R2} Size of the corresponding (omnibus or conditional) effect on the multivariate outcome. Note that the intercept term does not have an estimated effect size.
  \item \texttt{p-value} The p-value for each (omnibus or conditional) effect.
\end{itemize}

In addition to the information in the three columns comprising \texttt{summary(mvlm.res)}, the \texttt{mvlm.res} object also contains:

\begin{itemize}
  \item \texttt{p.prec} A \texttt{data.frame} reporting the precision of each p-value. These are the maximum error bound of the p-values reported by the \texttt{davies} function in \texttt{CompQuadForm}.
\end{itemize}
A matrix containing in its first row the overall variance explained by the model for variable comprising Y (columns). The remaining rows list the variance of each outcome that is explained by the conditional effect of each predictor.

Estimated regression coefficients.

Adjusted sample size used to determine whether or not the asymptotic properties of the model are likely to hold. See McArtor et al. (under review) for more detail.

Original input data and the model.matrix used to fit the model.

The formula passed to mvlm.

Note that the printed output of summary(res) will truncate p-values to the smallest trustworthy values, but the object returned by summary(mvlm.res) will contain the p-values as computed. If the error bound of the Davies algorithm is larger than the p-value, the only conclusion that can be drawn with certainty is that the p-value is smaller than (or equal to) the error bound.

Author(s)

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References


Examples

data(mvlmdata)

Y <- as.matrix(Y.mvlm)

# Main effects model
mvlm.res <- mvlm(Y ~ Cont + Cat + Ord, data = X.mvlm)
summary(mvlm.res)

# Include two-way interactions
mvlm.res.int <- mvlm(Y ~ .^2, data = X.mvlm)
summary(mvlm.res.int)
predict.mvlm

mvlm Model Predictions

Description

predict method for class mvlm. To predict using new data, the predictor data frame passed to newdata must have the same number of columns as the data used to fit the model, and the names of each variable must match the names of the original data.

Usage

## S3 method for class 'mvlm'
predict(object, newdata, ...)

Arguments

object Output from mvlm
newdata Data frame of observations on the predictors used to fit the model.
... Further arguments passed to or from other methods.

Value

A data frame of predicted values

Author(s)

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Examples

data(mvlmdata)
Y.train <- as.matrix(Y.mvlm[1:150,])
X.train <- X.mvlm[1:150,]

mvlm.res <- mvlm(Y.train ~ ., data = X.train)
X.test <- X.mvlm[151:200,]
Y.predict <- predict(mvlm.res, newdata = X.test)
print.mvlm  

Print mvlm Object

Description

print method for class mvlm

Usage

## S3 method for class 'mvlm'
print(x, ...)

Arguments

x  
Output from mvlm

...  
Further arguments passed to or from other methods.

Value

p-value  
Analytical p-values for the omnibus test and each predictor

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residuals.mvlm  

Extract mvlm Residuals

Description

residuals method for class mvlm.

Usage

## S3 method for class 'mvlm'
residuals(object, ...)

Arguments

object  
Output from mvlm

...  
Further arguments passed to or from other methods.

Value

A data frame of residuals with the same dimension as the outcome data passed to mvlm
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Examples

data(mvlmdata)
Y <- as.matrix(Y.mvlm)
mvlm.res <- mvlm(Y ~ Cont + Cat + Ord, data = X.mvlm)
Y.resid <- resid(mvlm.res)

summary.mvlm  Summarizing mvlm Results

Description
summary method for class mvlm

Usage

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

Arguments

object  Output from mvlm
...
Further arguments passed to or from other methods.

Value

Calling summary(mvlm.res) produces a data frame comprised of:

Statistic  Value of the corresponding test statistic.
Numerator DF  Numerator degrees of freedom for each test statistic.
Pseudo R2  Size of the corresponding (omnibus or conditional) effect on the multivariate outcome. Note that the intercept term does not have an estimated effect size.
p-value  The p-value for each (omnibus or conditional) effect.

In addition to the information in the three columns comprising summary(mvlm.res), the mvlm.res object also contains:

p.prec  A data.frame reporting the precision of each p-value. These are the maximum error bound of the p-values reported by the davies function in CompQuadForm.
y.rsq  A matrix containing in its first row the overall variance explained by the model for variable comprising Y (columns). The remaining rows list the variance of each outcome that is explained by the conditional effect of each predictor.
beta.hat  Estimated regression coefficients.
Adjusted sample size used to determine whether or not the asymptotic properties of the model are likely to hold. See McArtor et al. (under review) for more detail.

Original input data and the model.matrix used to fit the model.

Note that the printed output of summary(res) will truncate p-values to the smallest trustworthy values, but the object returned by summary(mvlm.res) will contain the p-values as computed. If the error bound of the Davies algorithm is larger than the p-value, the only conclusion that can be drawn with certainty is that the p-value is smaller than (or equal to) the error bound.

**Author(s)**

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**References**


**Examples**

```r
data(mvlmdata)
Y <- as.matrix(Y.mvlm)

# Main effects model
mvlm.res <- mvlm(Y ~ Cont + Cat + Ord, data = X.mvlm)
summary(mvlm.res)

# Include two-way interactions
mvlm.res.int <- mvlm(Y ~ .^2, data = X.mvlm)
summary(mvlm.res.int)
```

**Description**

See package vignette by calling vignette('mvlm-vignette').

**Usage**

X.mvlm
**Format**

An object of class `data.frame` with 200 rows and 3 columns.

---

`Y.mv1m`  
*Simulated outcome data to illustrate the mv1m package.*

---

**Description**

See package vignette by calling `vignette('mv1m-vignette')`.

**Usage**

`Y.mv1m`

**Format**

An object of class `matrix` with 200 rows and 5 columns.
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