

# Package ‘betaSandwich’

April 26, 2023

**Title** Robust Confidence Intervals for Standardized Regression Coefficients

**Version** 1.0.4

**Description** Generates robust confidence intervals for standardized regression coefficients using heteroskedasticity-consistent standard errors for models fitted by `lm()` as described in Dudgeon (2017) <[doi:10.1007/s11336-017-9563-z](https://doi.org/10.1007/s11336-017-9563-z)>. A description of the package and code examples are presented in Pesigan, Sun, and Cheung (2023) <[doi:10.1080/00273171.2023.2201277](https://doi.org/10.1080/00273171.2023.2201277)>.

**URL** <https://github.com/jeksterslab/betaSandwich>,  
<https://jeksterslab.github.io/betaSandwich/>

**BugReports** <https://github.com/jeksterslab/betaSandwich/issues>

**License** MIT + file LICENSE

**Encoding** UTF-8

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**Roxygen** list(markdown = TRUE)

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**Imports** methods

**Suggests** knitr, rmarkdown, testthat

**RoxygenNote** 7.2.3

**NeedsCompilation** no

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BetaADF	<i>Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix Using the Asymptotic Distribution-Free Approach</i>
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**Description**

Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix Using the Asymptotic Distribution-Free Approach

**Usage**

BetaADF(object)

**Arguments**

object                      Object of class `lm`.

**Details**

Note that while the calculation in `BetaADF()` is different from `betaDelta::BetaDelta()` with `type = "adf"`, the results are numerically equivalent. `BetaADF()` is appropriate when sample sizes are moderate to large ( $n > 250$ ). `BetaHC()` is recommended in most situations.

**Value**

Returns an object of class `betasandwich` which is a list with the following elements:

**call** Function call.

**args** Function arguments.

**lm\_process** Processed `lm` object.

**gamma\_n** Asymptotic covariance matrix of the sample covariance matrix assuming multivariate normality.

**gamma\_hc** Asymptotic covariance matrix HC correction.

**gamma** Asymptotic covariance matrix of the sample covariance matrix.

**acov** Asymptotic covariance matrix of the standardized slopes.

**vcov** Sampling covariance matrix of the standardized slopes.

**est** Vector of standardized slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**References**

Browne, M. W. (1984). Asymptotically distribution-free methods for the analysis of covariance structures. *British Journal of Mathematical and Statistical Psychology*, 37(1), 62–83. doi:10.1111/j.20448317.1984.tb00789.x

Dudgeon, P. (2017). Some improvements in confidence intervals for standardized regression coefficients. *Psychometrika*, 82(4), 928–951. doi:10.1007/s113360179563z

Pesigan, I. J. A., Sun, R. W., & Cheung, S. F. (2023). betaDelta and betaSandwich: Confidence intervals for standardized regression coefficients in R. *Multivariate Behavioral Research*. doi:10.1080/00273171.2023.2201277

**See Also**

Other Beta Sandwich Functions: [BetaHC\(\)](#), [BetaN\(\)](#), [DiffBetaSandwich\(\)](#), [RSqBetaSandwich\(\)](#)

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaADF(object)
# Methods -----
print(std)
summary(std)
coef(std)
vcov(std)
confint(std, level = 0.95)
```

BetaHC

*Estimate Standardized Regression Coefficients and the Corresponding Robust Sampling Covariance Matrix Using the Heteroskedasticity Consistent Approach*

## Description

Estimate Standardized Regression Coefficients and the Corresponding Robust Sampling Covariance Matrix Using the Heteroskedasticity Consistent Approach

## Usage

```
BetaHC(object, type = "hc3", g1 = 1, g2 = 1.5, k = 0.7)
```

## Arguments

<code>object</code>	Object of class <code>lm</code> .
<code>type</code>	Character string. Correction type. Possible values are "hc0", "hc1", "hc2", "hc3", "hc4", "hc4m", and "hc5".
<code>g1</code>	Numeric. g1 value for type = "hc4m" or type = "hc5".
<code>g2</code>	Numeric. g2 value for type = "hc4m".
<code>k</code>	Numeric. Constant for type = "hc5"

## Value

Returns an object of class `betasandwich` which is a list with the following elements:

**call** Function call.

**args** Function arguments.

**lm\_process** Processed `lm` object.

**gamma\_n** Asymptotic covariance matrix of the sample covariance matrix assuming multivariate normality.

**gamma\_hc** Asymptotic covariance matrix HC correction.

**gamma** Asymptotic covariance matrix of the sample covariance matrix.

**acov** Asymptotic covariance matrix of the standardized slopes.

**vcov** Sampling covariance matrix of the standardized slopes.

**est** Vector of standardized slopes.

## Author(s)

Ivan Jacob Agaloos Pesigan

References

Dudgeon, P. (2017). Some improvements in confidence intervals for standardized regression coefficients. *Psychometrika*, 82(4), 928–951. doi:10.1007/s113360179563z

Pesigan, I. J. A., Sun, R. W., & Cheung, S. F. (2023). betaDelta and betaSandwich: Confidence intervals for standardized regression coefficients in R. *Multivariate Behavioral Research*. doi:10.1080/00273171.2023.2201277

See Also

Other Beta Sandwich Functions: [BetaADF\(\)](#), [BetaN\(\)](#), [DiffBetaSandwich\(\)](#), [RSqBetaSandwich\(\)](#)

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
# Methods -----
print(std)
summary(std)
coef(std)
vcov(std)
confint(std, level = 0.95)
```

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BetaN	<i>Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix Assuming Multivariate Normality</i>
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Description

Estimate Standardized Regression Coefficients and the Corresponding Sampling Covariance Matrix Assuming Multivariate Normality

Usage

```
BetaN(object)
```

Arguments

object                      Object of class lm.

Details

Note that while the calculation in `BetaN()` is different from `betaDelta::BetaDelta()` with `type = "mvn"`, the results are numerically equivalent. `BetaN()` assumes multivariate normality. `BetaHC()` is recommended in most situations.

**Value**

Returns an object of class `betasandwich` which is a list with the following elements:

**call** Function call.

**args** Function arguments.

**lm\_process** Processed `lm` object.

**gamma\_n** Asymptotic covariance matrix of the sample covariance matrix assuming multivariate normality.

**gamma\_hc** Asymptotic covariance matrix HC correction.

**gamma** Asymptotic covariance matrix of the sample covariance matrix.

**acov** Asymptotic covariance matrix of the standardized slopes.

**vcov** Sampling covariance matrix of the standardized slopes.

**est** Vector of standardized slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**References**

Dudgeon, P. (2017). Some improvements in confidence intervals for standardized regression coefficients. *Psychometrika*, 82(4), 928–951. doi:10.1007/s113360179563z

Pesigan, I. J. A., Sun, R. W., & Cheung, S. F. (2023). betaDelta and betaSandwich: Confidence intervals for standardized regression coefficients in R. *Multivariate Behavioral Research*. doi:10.1080/00273171.2023.2201277

**See Also**

Other Beta Sandwich Functions: [BetaADF\(\)](#), [BetaHC\(\)](#), [DiffBetaSandwich\(\)](#), [RSqBetaSandwich\(\)](#)

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaN(object)
# Methods -----
print(std)
summary(std)
coef(std)
vcov(std)
confint(std, level = 0.95)
```

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coef.betasandwich	<i>Standardized Regression Slopes</i>
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**Description**

Standardized Regression Slopes

**Usage**

```
## S3 method for class 'betasandwich'  
coef(object, ...)
```

**Arguments**

object	Object of class betasandwich.
...	additional arguments.

**Value**

Returns a vector of standardized regression slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)  
std <- BetaHC(object)  
coef(std)
```

---

coef.diffbetasandwich	<i>Differences of Standardized Regression Slopes</i>
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---

**Description**

Differences of Standardized Regression Slopes

**Usage**

```
## S3 method for class 'diffbetasandwich'  
coef(object, ...)
```

**Arguments**

object	Object of class diffbetasandwich.
...	additional arguments.

**Value**

Returns a vector of differences of standardized regression slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
coef(diff)
```

---

coef.rsqbetasandwich	<i>Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)</i>
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**Description**

Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)

**Usage**

```
## S3 method for class 'rsqbetasandwich'
coef(object, ...)
```

**Arguments**

object	Object of class rsqbetasandwich.
...	additional arguments.

**Value**

Returns a vector of multiple correlation coefficients (R-squared and adjusted R-squared)

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
coef(rsq)
```



---

confint.betasandwich    *Confidence Intervals for Standardized Regression Slopes*

---

## Description

Confidence Intervals for Standardized Regression Slopes

## Usage

```
## S3 method for class 'betasandwich'
confint(object, parm = NULL, level = 0.95, ...)
```

## Arguments

object	Object of class betasandwich.
parm	a specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
level	the confidence level required.
...	additional arguments.

## Value

Returns a matrix of confidence intervals.

## Author(s)

Ivan Jacob Agaloos Pesigan

## Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
confint(std, level = 0.95)
```

---

confint.diffbetasandwich    *Confidence Intervals for Differences of Standardized Regression Slopes*

---

## Description

Confidence Intervals for Differences of Standardized Regression Slopes

**Usage**

```
## S3 method for class 'diffbetasandwich'
confint(object, parm = NULL, level = 0.95, ...)
```

**Arguments**

object	Object of class diffbetasandwich.
parm	a specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
level	the confidence level required.
...	additional arguments.

**Value**

Returns a matrix of confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
confint(diff, level = 0.95)
```

---

confint.rsqbetasandwich

*Confidence Intervals for Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)*

---

**Description**

Confidence Intervals for Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)

**Usage**

```
## S3 method for class 'rsqbetasandwich'
confint(object, parm = NULL, level = 0.95, ...)
```

**Arguments**

<code>object</code>	Object of class <code>rsqbetasandwich</code> .
<code>parm</code>	a specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
<code>level</code>	the confidence level required.
<code>...</code>	additional arguments.

**Value**

Returns a matrix of confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
confint(rsq, level = 0.95)
```

---

DiffBetaSandwich	<i>Estimate Differences of Standardized Slopes and the Corresponding Sampling Covariance Matrix</i>
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---

**Description**

Estimate Differences of Standardized Slopes and the Corresponding Sampling Covariance Matrix

**Usage**

```
DiffBetaSandwich(object)
```

**Arguments**

<code>object</code>	Object of class <code>betasandwich</code> , that is, the output of the <code>BetaHC()</code> , <code>BetaN()</code> , or <code>BetaADF()</code> functions.
---------------------	--

**Value**

Returns an object of class `diffbetasandwich` which is a list with the following elements:

**call** Function call.

**fit** The argument object.

**vcov** Sampling covariance matrix of differences of standardized slopes.

**est** Vector of differences of standardized slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**See Also**

Other Beta Sandwich Functions: [BetaADF\(\)](#), [BetaHC\(\)](#), [BetaN\(\)](#), [RSqBetaSandwich\(\)](#)

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
# Methods -----
print(diff)
summary(diff)
coef(diff)
vcov(diff)
confint(diff, level = 0.95)
```

---

nas1982

*1982 National Academy of Sciences Doctoral Programs Data*

---

**Description**

1982 National Academy of Sciences Doctoral Programs Data

**Usage**

nas1982

**Format**

Ratings of 46 doctoral programs in psychology in the USA with the following variables:

**QUALITY** Program quality ratings.

**NFACUL** Number of faculty members in the program.

**NGRADS** Number of program graduates.

**PCTSUPP** Percentage of program graduates who received support.

**PCTGRT** Percent of faculty members holding research grants.

**NARTIC** Number of published articles attributed to program faculty member.

**PCTPUB** Percent of faculty with one or more published article.

**References**

National Research Council. (1982). *An assessment of research-doctorate programs in the United States: Social and behavioral sciences*. doi:10.17226/9781. Reproduced with permission from the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.

---

print.betasandwich	<i>Print Method for an Object of Class betasandwich</i>
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---

**Description**

Print Method for an Object of Class betasandwich

**Usage**

```
## S3 method for class 'betasandwich'  
print(x, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

**Arguments**

x	Object of class betasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of standardized regression slopes, standard errors, test statistics, p-values, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)  
std <- BetaHC(object)  
print(std)
```

---

print.diffbetasandwich	<i>Print Method for an Object of Class diffbetasandwich</i>
------------------------	---

---

**Description**

Print Method for an Object of Class diffbetasandwich

**Usage**

```
## S3 method for class 'diffbetasandwich'  
print(x, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

**Arguments**

x	Object of class diffbetasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of differences of standardized regression slopes, standard errors, test statistics, p-values, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
print(diff)
```

---

print.rsqbetasandwich *Print Method for an Object of Class rsqbetasandwich*

---

**Description**

Print Method for an Object of Class rsqbetasandwich

**Usage**

```
## S3 method for class 'rsqbetasandwich'
print(x, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

**Arguments**

x	Object of class rsqbetasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of multiple correlation coefficients (R-squared and adjusted R-squared), standard errors, test statistics, p-values, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
print(rsq)
```

---

RSqBetaSandwich	<i>Estimate Multiple Correlation Coefficients (R-squared and adjusted R-squared) and the Corresponding Sampling Covariance Matrix</i>
-----------------	---

---

**Description**

Estimate Multiple Correlation Coefficients (R-squared and adjusted R-squared) and the Corresponding Sampling Covariance Matrix

**Usage**

```
RSqBetaSandwich(object)
```

**Arguments**

**object** Object of class betasandwich, that is, the output of the BetaHC(), BetaN(), or BetaADF() functions.

**Value**

Returns an object of class rsqbetasandwich which is a list with the following elements:

**call** Function call.

**fit** The argument object.

**vcov** Sampling covariance matrix of multiple correlation coefficients (R-squared and adjusted R-squared).

**est** Vector of multiple correlation coefficients (R-squared and adjusted R-squared).

**Author(s)**

Ivan Jacob Agaloos Pesigan

**See Also**

Other Beta Sandwich Functions: [BetaADF\(\)](#), [BetaHC\(\)](#), [BetaN\(\)](#), [DiffBetaSandwich\(\)](#)

**Examples**

```

object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
# Methods -----
print(rsq)
summary(rsq)
coef(rsq)
vcov(rsq)
confint(rsq, level = 0.95)

```

---

summary.betasandwich    *Summary Method for an Object of Class betasandwich*

---

**Description**

Summary Method for an Object of Class betasandwich

**Usage**

```

## S3 method for class 'betasandwich'
summary(object, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)

```

**Arguments**

object	Object of class betasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

**Value**

Returns a matrix of standardized regression slopes, standard errors, test statistics, p-values, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```

object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
summary(std)

```



---

`summary.diffbetasandwich`*Summary Method for an Object of Class diffbetasandwich*

---

## Description

Summary Method for an Object of Class diffbetasandwich

## Usage

```
## S3 method for class 'diffbetasandwich'  
summary(object, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

## Arguments

<code>object</code>	Object of class diffbetasandwich.
<code>alpha</code>	Significance level.
<code>digits</code>	Digits to print.
<code>...</code>	additional arguments.

## Value

Returns a matrix of differences of standardized regression slopes, standard errors, test statistics, p-values, and confidence intervals.

## Author(s)

Ivan Jacob Agaloos Pesigan

## Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)  
std <- BetaHC(object)  
diff <- DiffBetaSandwich(std)  
summary(diff)
```

summary.rsqbetasandwich

*Summary Method for an Object of Class rsqbetasandwich*

---

## Description

Summary Method for an Object of Class rsqbetasandwich

## Usage

```
## S3 method for class 'rsqbetasandwich'  
summary(object, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

## Arguments

object	Object of class rsqbetasandwich.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

## Value

Returns a matrix of multiple correlation coefficients (R-squared and adjusted R-squared), standard errors, test statistics, p-values, and confidence intervals.

## Author(s)

Ivan Jacob Agaloos Pesigan

## Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)  
std <- BetaHC(object)  
rsq <- RSqBetaSandwich(std)  
summary(rsq)
```

---

vcov.betasandwich	<i>Sampling Covariance Matrix of the Standardized Regression Slopes</i>
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---

**Description**

Sampling Covariance Matrix of the Standardized Regression Slopes

**Usage**

```
## S3 method for class 'betasandwich'
vcov(object, ...)
```

**Arguments**

object	Object of class betasandwich.
...	additional arguments.

**Value**

Returns a matrix of the variance-covariance matrix of standardized slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
vcov(std)
```

---

vcov.diffbetasandwich	<i>Sampling Covariance Matrix of Differences of Standardized Regression Slopes</i>
-----------------------	--

---

**Description**

Sampling Covariance Matrix of Differences of Standardized Regression Slopes

**Usage**

```
## S3 method for class 'diffbetasandwich'
vcov(object, ...)
```

**Arguments**

object            Object of class `diffbetasandwich`.  
 ...              additional arguments.

**Value**

Returns a matrix of the variance-covariance matrix of differences of standardized regression slopes.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
diff <- DiffBetaSandwich(std)
vcov(diff)
```

---

`vcov.rsqbetasandwich`    *Sampling Covariance Matrix of Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)*

---

**Description**

Sampling Covariance Matrix of Multiple Correlation Coefficients (R-Squared and Adjusted R-Squared)

**Usage**

```
## S3 method for class 'rsqbetasandwich'
vcov(object, ...)
```

**Arguments**

object            Object of class `rsqbetasandwich`.  
 ...              additional arguments.

**Value**

Returns a matrix of the variance-covariance matrix of multiple correlation coefficients (R-squared and adjusted R-squared).

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaHC(object)
rsq <- RSqBetaSandwich(std)
vcov(rsq)
```

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