

# Package ‘regDIF’

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**Title** Regularized Differential Item Functioning

**Version** 1.1.0

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**Description** Performs regularization of differential item functioning (DIF) parameters in item response theory (IRT) models (Belzak & Bauer, 2020) <<https://pubmed.ncbi.nlm.nih.gov/31916799/>> using a penalized expectation-maximization algorithm.

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**Imports** stats (> 3.0.0), utils, statmod, parallel, foreach

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regDIF-package	<i>Regularized differential item functioning for IRT and CFA models.</i>
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**Description**

Regularized Differential Item Functioning

**Details**

**regDIF** is a package that performs regularization of differential item functioning (DIF) in item response theory (IRT) and confirmatory factor analysis (CFA) models using a penalized expectation-maximization algorithm.

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coef.regDIF	<i>Coefficient function for regDIF function</i>
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**Description**

Coefficient function for regDIF function

**Usage**

```
## S3 method for class 'regDIF'
coef(object, tau = NULL, method = "bic", ...)
```

**Arguments**

object	Fitted regDIF model object.
tau	Optional character or numeric indicating the tau(s) at which the model coefficients are returned. For character value, may be "tau.min", which returns model coefficients for the value of tau at which the minimum fit statistic is identified. For numeric, the value(s) provided corresponds to the value(s) of tau.
method	Character value indicating the model fit statistic to be used for determining "tau.min". Default is "bic". May also be "aic".
...	Additional arguments to be passed through to coef.

**Value**

NULL

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ida	<i>Simulated data example with multiple DIF covariates</i>
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**Description**

A simulated dataset containing six binary items and three DIF covariates

**Usage**

```
ida
```

**Format**

A data frame with 500 rows and 9 variables:

```
item1
item2
item3
item4
item5
item6
age
gender
study ...
```

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plot.regDIF	<i>Plot function for regDIF function</i>
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**Description**

Plot function for regDIF function

**Usage**

```
## S3 method for class 'regDIF'
plot(x, y = NULL, method = "bic", color.seed = 123, legend.plot = TRUE, ...)
```

**Arguments**

x	Fitted regDIF model object.
y	Unused for plotting regDIF model object.
method	Fit statistic to use for identifying DIF effects in plot.
color.seed	Random seed to sample line colors and line types for DIF effects in plot.
legend.plot	Logical indicating whether to plot a legend. Default is TRUE.
...	Additional arguments to be passed through to plot.

**Value**

a "plot" object for a "regDIF" fit

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print.regDIF	<i>Print function for regDIF function</i>
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**Description**

Print function for regDIF function

**Usage**

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

**Arguments**

x	Fitted regDIF model object.
...	Additional arguments to be passed through print.

**Value**

NULL

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regDIF	<i>Regularized Differential Item Functioning</i>
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**Description**

Identify DIF in item response theory models using regularization.

**Usage**

```
regDIF(item.data,
       pred.data,
       prox.data = NULL,
       item.type = NULL,
       pen.type = NULL,
       pen.deriv = FALSE,
       tau = NULL,
       num.tau = 100,
       alpha = 1,
       gamma = 3,
       anchor = NULL,
       stdz = TRUE,
       control = list())
```

**Arguments**

item.data	Matrix or data frame of item responses. See below for supported item types.
pred.data	Matrix or data frame of predictors affecting item responses (DIF) and latent variable (impact). See control option below to specify different predictors for impact model.
prox.data	Optional vector of observed scores to serve as a proxy for the latent variable. If a vector is supplied, a multivariate regression model will be fit to the data. The default is NULL, indicating that latent scores will be estimated during model estimation.
item.type	Optional character value or vector indicating the type of item to be modeled. The default is NULL, corresponding to a 2PL or graded item type. Different item types may be specified for a single model by providing a vector equal in length to the number of items in item.data. The options include: <ul style="list-style-type: none"> <li>• "rasch" - Slopes constrained to 1 and intercepts freely estimated.</li> <li>• "2pl" - Slopes and intercepts freely estimated.</li> <li>• "graded" - Slopes, intercepts, and thresholds freely estimated.</li> <li>• "cfa"</li> </ul>
pen.type	Optional character value indicating the penalty function to use. The default is NULL, corresponding to the LASSO function. The options include: <ul style="list-style-type: none"> <li>• "lasso" - The least absolute selection and shrinkage operator (LASSO), which controls DIF selection through <math>\tau</math> (tau).</li> <li>• "mcp" - The minimax concave penalty (MCP), which controls DIF selection through <math>\tau</math> (tau) and estimator bias through <math>\gamma</math> (gamma). Uses the firm-thresholding penalty function.</li> <li>• "grp.lasso" - The group version of the LASSO penalty, which selects intercept and slope DIF effects on each background characteristic together.</li> <li>• "grp.mcp" - The group version of the MCP function.</li> </ul>
pen.deriv	Logical value indicating whether to use the second derivative of the penalized parameter during regularization. The default is FALSE.
tau	Optional numeric vector of tau values $\geq 0$ . If tau is supplied, this overrides the automatic construction of tau values. Must be non-negative and in descending order, from largest to smallest values (e.g., seq(1, 0, -.01)).
num.tau	Numeric value indicating how many tau values to fit. The default is 100.
alpha	Numeric value indicating the alpha parameter in the elastic net penalty function. Alpha controls the degree to which LASSO or ridge is used during regularization. The default is 1, which is equivalent to LASSO. NOTE: If using MCP penalty, alpha may not be exactly 0.
gamma	Numeric value indicating the gamma parameter in the MCP function. Gamma controls the degree of tapering of DIF effects as tau decreases. Larger gamma leads to faster tapering (less bias but possibly more unstable optimization), whereas smaller gamma leads to slower tapering (more bias but more stable optimization). Default is 3. Must be greater than 1.

anchor	Optional numeric value or vector indicating which item response(s) are anchors (e.g., anchor = 1). Default is NULL, meaning at least one DIF effect per covariate will be fixed to zero as tau approaches 0 (required to identify the model).
stdz	Logical value indicating whether to standardize DIF and impact predictors for regularization. Default is TRUE, as it is recommended that all predictors be on the same scale.
control	Optional list of different model specifications and optimization parameters. May be: <ul style="list-style-type: none"> <li><b>impact.mean.data</b> Matrix or data frame of predictors, which allows for a different set of predictors to affect the mean impact equation compared to the item response DIF equations. Default includes all predictors from pred.data.</li> <li><b>impact.var.data</b> Matrix or data frame with predictors for variance impact. See above. Default includes all predictors in pred.data.</li> <li><b>tol</b> Convergence threshold of EM algorithm. Default is <math>10^{-5}</math>.</li> <li><b>maxit</b> Maximum number of EM iterations. Default is 2000.</li> <li><b>adapt.quad</b> Logical value indicating whether to use adaptive quadrature to approximate the latent variable. The default is FALSE. NOTE: Adaptive quadrature is not supported yet.</li> <li><b>num.quad</b> Numeric value indicating the number of quadrature points to be used. For fixed-point quadrature, the default is 21 points when all item responses are binary or else 51 points if at least one item is ordered categorical.</li> <li><b>int.limits</b> Vector of 2 numeric values indicating the integral limits for quadrature. Default is c(-6,6).</li> <li><b>optim.method</b> Character value indicating which optimization method to use. Default is "UNR", which updates estimates one-at-a-time using univariate Newton-Raphson, or a single iteration of coordinate descent. Another option is "MNR", which updates the impact and item parameter estimates using Multivariate Newton-Raphson. A third option is "CD", or coordinate descent with complete iterations through all parameters until convergence. "MNR" will be faster in most cases, although "UNR" may achieve faster results when the number of predictors is large.</li> <li><b>start.values</b> List of numbers assigned as starting values to the regDIF procedure. List must contain only the following names: impact, for mean and variance impact parameters, in the order that is given by an object of class coef.regDIF; base, for base intercept and slope parameters, in order given by a coef.regDIF object; and finally, dif, for intercept and slope DIF parameters, again in order given by a coef.regDIF object.</li> </ul>

### Value

Function returns an object of class regDIF, which is a list of results from the regularization routine

### Examples

```
library(regDIF)
```

```
head(ida)
item.data <- ida[,1:6]
pred.data <- ida[,7:9]
prox.data <- rowSums(item.data)
fit <- regDIF(item.data, pred.data, prox.data, num.tau = 10)
summary(fit)
```

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summary.regDIF

*Summary function for regDIF function*

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## Description

Summary function for regDIF function

## Usage

```
## S3 method for class 'regDIF'
summary(object, method = "bic", ...)
```

## Arguments

object	Fitted regDIF model object.
method	Fit statistic to use for displaying minimum tau model.
...	Additional arguments to be passed through summary.

## Value

NULL

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