

# Package ‘MPWR’

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**Type** Package

**Title** Multiple Polynomial Piecewise Regression ('MPWR') for Optimal Multivariate Time-Series Segmentation

**Version** 0.1.0

**Description** A multiple polynomial piecewise regression model for the optimal segmentation of multivariate time series with regime changes. It uses MLE for the estimation of the regression parameters with dynamic programming for the segmentation. Originally developped and written in 'Matlab' by Faicel Chamroukhi <<https://github.com/fchamroukhi/MPWR>>

**URL** [https://github.com/fchamroukhi/MPWR\\_r](https://github.com/fchamroukhi/MPWR_r)

**License** GPL (>= 3)

**Depends** R (>= 2.10)

**Imports** methods,  
stats,  
Rcpp

**Suggests** knitr,  
rmarkdown

**LinkingTo** Rcpp,  
RcppArmadillo

**Collate** MPWR-package.R  
RcppExports.R  
utils.R  
MData.R  
dynamicProg.R  
ParamMPWR.R  
StatMPWR.R  
ModelMPWR.R  
fitMPWR.R  
data-realdataset.R  
data-toydataset.R

**VignetteBuilder** knitr

**Encoding** UTF-8

**LazyData** true

**Roxygen** list(markdown = TRUE)

**RoxygenNote** 6.1.1

R topics documented:

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MPWR-package	<i>MPWR: Multiple Polynomial Piecewise Regression ('MPWR') for Optimal Multivariate Time-Series Segmentation</i>
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Description

A multiple polynomial piecewise regression model for the optimal segmentation of multivariate time series with regime changes. It uses MLE for the estimation of the regression parameters with dynamic programming for the segmentation. Originally developped and written in 'Matlab' by Faicel Chamroukhi <<https://github.com/fchamroukhi/MPWR>>

Author(s)

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See Also

Useful links:  

- [https://github.com/fchamroukhi/MPWR\\_r](https://github.com/fchamroukhi/MPWR_r)

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fitMPWR	<i>fitMPWR implements an optimized dynamic programming algorithm to fit a PWR model.</i>
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Description

fitMPWR is used to fit a Multivariate Piecewise Regression (PWR) model by maximum-likelihood via an optimized dynamic programming algorithm. The estimation performed by the dynamic programming algorithm provides an optimal segmentation of the time series.

Usage

fitMPWR(X, Y, K, p = 3)

**Arguments**

X	Numeric vector of length $m$ representing the covariates/inputs $x_1, \dots, x_m$ .
Y	Matrix of size $(m, d)$ representing a $d$ dimension function of $X$ observed at points $1, \dots, m$ . $Y$ is the observed response/output.
K	The number of regimes/segments (PWR components).
p	Optional. The order of the polynomial regression. By default, p is set at 3.

**Details**

fitMPWR function implements an optimized dynamic programming algorithm of the MPWR model. This function starts with the calculation of the "cost matrix" then it estimates the transition points given K the number of regimes thanks to the method computeDynamicProgram (method of the class [ParamMPWR](#)).

**Value**

fitMPWR returns an object of class [ModelMPWR](#).

**See Also**

[ModelMPWR](#), [ParamMPWR](#), [StatMPWR](#)

**Examples**

```
data(toydataset)
x <- toydataset$x
Y <- as.matrix(toydataset[,c("y1", "y2", "y3")])

mpwr <- fitMPWR(X = x, Y = Y, K = 5, p = 1)

mpwr$summary()

mpwr$plot()
```

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MData-class

*A Reference Class which represents multivariate data.*


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**Description**

MData is a reference class which represents multivariate objects. The data can be ordered by time (multivariate time series). In the last case, the field X represents the time.

**Fields**

- X Numeric vector of length  $m$ .
- Y Matrix of size  $(m, d)$  representing a  $d$  dimension function of  $X$  observed at points  $1, \dots, m$ .

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ModelMPWR-class

*A Reference Class which represents a fitted MPWR model.*


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## Description

ModelMPWR represents an estimated MPWR model.

## Fields

param A [ParamMPWR](#) object. It contains the estimated values of the parameters.

stat A [StatMPWR](#) object. It contains all the statistics associated to the MPWR model.

## Methods

plot(what = c("regressors", "segmentation"), ...) Plot method.

what The type of graph requested:

- "regressors" = Polynomial regression components (field regressors of class [StatMPWR](#)).
- "segmentation" = Estimated signal (field mean\_function of class [StatMPWR](#)).

... Other graphics parameters.

By default, all the graphs mentioned above are produced.

summary(digits = getOption("digits")) Summary method.

digits The number of significant digits to use when printing.

## See Also

[ParamMPWR](#), [StatMPWR](#)

## Examples

```
data(toydataset)
x <- toydataset$x
Y <- as.matrix(toydataset[,c("y1", "y2", "y3")])

mpwr <- fitMPWR(X = x, Y = Y, K = 5, p = 1)

# mpwr is a ModelMPWR object. It contains some methods such as 'summary' and 'plot'
mpwr$summary()
mpwr$plot()

# mpwr has also two fields, stat and param which are reference classes as well

# Value of the objective function:
mpwr$stat$objective

# Parameters of the polynomial regressions:
mpwr$param$beta
```

ParamMPWR-class

*A Reference Class which contains the parameters of a PWR model.***Description**

ParamMPWR contains all the parameters of a PWR model. The parameters are calculated by the initialization Method and then updated by the Method dynamic programming (here dynamic programming)

**Fields**

- X Numeric vector of length  $m$  representing the covariates/inputs  $x_1, \dots, x_m$ .
- Y Numeric vector of length  $m$  representing the observed response/output  $y_1, \dots, y_m$ .
- m Numeric. Length of the response/output vector Y.
- K The number of regimes (PWR components).
- p The order of the polynomial regression. p is fixed to 3 by default.
- gamma Set of transition points. gamma is a column matrix of size  $(K + 1, 1)$ .
- beta Parameters of the polynomial regressions. beta is an array of dimension  $(p + 1, d, K)$ , with p the order of the polynomial regression, d the dimension of the multivariate time-series. p is fixed to 3 by default.
- sigma2 The variances for the K regimes. sigma2 is an array of size  $(d, d, K)$ .
- phi A matrix giving the regression design matrix for the polynomial regression.

**Methods**

- computeDynamicProgram(C1, K) Method which implements the dynamic programming based on the cost matrix C1 and the number of regimes/segments K.
- computeParam() Method which estimates the parameters beta and sigma2 knowing the transition points gamma.

realdataset

*Time series representing the three acceleration components recorded over time with body mounted accelerometers during the activity of a given person.***Description**

This dataset is provided for illustration only and represents the three acceleration components recorded over time with body mounted accelerometers during the activity of a given person. These data consist therefore of multidimensional time series with several regime changes over time, each regime is associated with an activity.

**Usage**

realdataset

**Format**

A data frame with 2253 rows and 4 columns:

**x** The covariate variable (the sampling time).

**y1** X axis component of the acceleration.

**y2** Y axis component of the acceleration.

**y3** Z axis component of the acceleration.

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StatMPWR-class

*A Reference Class which contains statistics of a PWR model.*


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**Description**

StatMPWR contains all the statistics associated to a [MPWR](#) model.

**Fields**

**z\_ik** Logical matrix of dimension  $(m, K)$  giving the class vector.

**klas** Column matrix of the labels issued from **z\_ik**. Its elements are  $klas(i) = k, k = 1, \dots, K$ .

**mean\_function** Approximation of the time series given the estimated parameters. **mean\_function** is a matrix of size  $(m, d)$ .

**regressors** Array of size  $(m, d, K)$  giving the values of the estimated polynomial regression components.

**objective** Numeric. Value of the objective function.

**Methods**

**computeStats(paramMPWR)** Method used at the end of the dynamic programming algorithm to compute statistics based on parameters provided by **paramMPWR**.

**See Also**

[ParamMPWR](#)

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toydataset

*A simulated non-stationary multidimensional time series with regime changes.*


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**Description**

A simulated non-stationary multidimensional time series with five regimes (segments). This time series is used for illustration.

**Usage**

toydataset

**Format**

A data frame with 670 rows and 4 columns:

**x** The covariate variable (the sampling time for time series).

**y1** The first dimension of the time series. The latter has been generated as follows:

- First regime: 100 values of standard Normally distributed random numbers.
- Second regime: 120 values of Normally distributed random numbers with mean 7 and unit variance.
- Third regime: 200 values of Normally distributed random numbers with mean 4 and unit variance.
- Fourth regime: 100 values of Normally distributed random numbers with mean -1 and unit variance.
- Fifth regime: 150 values of Normally distributed random numbers with mean 3.5 and unit variance.

**y2** The second dimension of the time series. The latter has been generated as follows:

- First regime: 100 values of Normally distributed random numbers with mean 1 and unit variance.
- Second regime: 120 values of Normally distributed random numbers with mean 5 and unit variance.
- Third regime: 200 values of Normally distributed random numbers with mean 6 and unit variance.
- Fourth regime: 100 values of Normally distributed random numbers with mean -2 and unit variance.
- Fifth regime: 150 values of Normally distributed random numbers with mean 2 and unit variance.

**y3** The third dimension of the time series. The latter has been generated as follows:

- First regime: 100 values of Normally distributed random numbers with mean -2 and unit variance.
- Second regime: 120 values of Normally distributed random numbers with mean 10 and unit variance.
- Third regime: 200 values of Normally distributed random numbers with mean 8 and unit variance.
- Fourth regime: 100 values of Normally distributed random numbers and unit variance.
- Fifth regime: 150 values of Normally distributed random numbers with mean 5 and unit variance.

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