

# Package ‘MVOPR’

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**Type** Package

**Title** Multi-View Orthogonal Projection Regression for Multi-Modality Integration

**Version** 2.0.0

**Description**

Implements the 'MVOPR' (Multi-View Orthogonal Projection Regression) method for robust variable selection and integration of multi-modality data.

**License** GPL-2 | GPL-3

**Encoding** UTF-8

**Imports** ncvreg, rrpak

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**Author** Zongrui Dai [aut, cre] (ORCID: <<https://orcid.org/0000-0002-7893-5004>>),  
Gen Li [aut]

**Maintainer** Zongrui Dai <daizr@umich.edu>

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**Description**

Fit Multi-View Orthogonal Projection Regression for two modalities with Lasso, MCP, SCAD. The function is capable for linear, logistic, and poisson regression.

**Usage**

```
MVOPR2(
  M1,
  M2,
  Y,
  RRR_Control = list(Sparsity = TRUE, nrank = 10, ic.type = "GIC"),
  family = "gaussian",
  penalty = "lasso"
)
```

**Arguments**

M1	A numeric matrix (n x p) for the first modality.
M2	A numeric matrix (n x q) for the second modality. Assumes 'M2' is correlated to 'M1' via a low-rank matrix.
Y	A numeric response vector of length 'n', connected to 'M1' and 'M2'.
RRR_Control	A list to control the fitting for reduced rank regression. Sparsity Logical. If 'TRUE', performs Sparse Orthogonal Factor Regression (SOFAR); otherwise, a reduced-rank regression model is fitted. nrank Integer. Maximum rank to be searched for the reduced-rank model. ic.type Character. Model selection criterion: "AIC", "BIC", or "GIC".
family	Either "gaussian", "binomial", or "poisson", depending on the response.
penalty	The penalty to be applied in the outcome model Y to M1 and M2. Either "MCP" (the default), "SCAD", or "lasso".

**Value**

A list containing:

`fitY` Results for Outcome regression ( $Y \sim M1 + M2$ ). A fitted object from 'cv.ncvreg', which contains the penalized regression results for 'Y'.

`fitM2` Results for reduced-rank regression ( $M2 \sim M1$ ). The fitted reduced-rank regression model from 'rrpack'.

`coefY` A vector of estimated regression coefficients for 'M1' and 'M2' on 'Y'.

`coefM2` A matrix of estimated regression coefficients for 'M1' on 'M2'.

rank An integer indicates the estimated rank of the reduced-rank regression.

P A projection matrix used to extract the orthogonal components of ‘M1’.

M1s Transformed version of ‘M1’ after projection.

M2s Transformed version of ‘M2’ after removing the effect of ‘M1’.

## References

Dai, Z., Huang, Y. J., & Li, G. (2025). Multi-View Orthogonal Projection Regression with Application in Multi-omics Integration. arXiv preprint arXiv:2503.16807. Available at <<https://arxiv.org/abs/2503.16807>>

## Examples

```
## Simulation.1
p = 100; q = 100; n = 200
rank = 3

beta = c(rep(c(rep(1,5),rep(0,95)),2))
M1 = matrix(rnorm(p*n),n,p)

U = matrix(rnorm(rank*p),p,rank)
V = matrix(rnorm(rank*q),rank,q)
B = U %>% V
E = matrix(rnorm(q*n),n,q)
M2 = M1 %>% B + E
Y = cbind(M1,M2) %>% matrix(beta,p+q,1)

Fit = MVOPR2(M1,M2,Y,RRR_Control = list(Sparsity = FALSE))

## Result for variable selection
print(data.frame(Trucoef = beta,estimate = Fit$CoefY[2:(p+q+1)]))

## Plot the pathway and cv error in outcome model
oldpar <- par(mfrow = c(1, 2))
on.exit(par(oldpar))
plot(Fit$fitY$fit)
plot(Fit$fitY)
```

## Description

Fit Multi-View Orthogonal Projection Regression for three modalities with Lasso, MCP, SCAD. The function is capable for linear, logistic, and poisson regression.

**Usage**

```
MVOPR3(
  M1,
  M2,
  M3,
  Y,
  RRR_Control = list(Sparsity = TRUE, nrank = 10, ic.type = "GIC"),
  family = "gaussian",
  penalty = "lasso"
)
```

**Arguments**

M1	A numeric matrix (n x p1) for the first modality.
M2	A numeric matrix (n x p2) for the second modality. Assumes 'M2' is correlated to 'M1' via a low-rank matrix.
M3	A numeric matrix (n x p3) for the third modality. Assumes 'M3' is correlated to 'M1' and 'M2' via a low-rank matrix.
Y	A numeric response vector of length 'n', connected to 'M1', 'M2', and 'M3'.
RRR_Control	A list to control the fitting for reduced rank regression. Sparsity Logical. If 'TRUE', performs Sparse Orthogonal Factor Regression (SOFAR); otherwise, a reduced-rank regression model is fitted. nrank Integer. Maximum rank to be searched for the reduced-rank model. ic.type Character. Model selection criterion: "AIC", "BIC", or "GIC".
family	Either "gaussian", "binomial", or "poisson", depending on the response.
penalty	The penalty to be applied in the outcome model Y to M1 and M2. Either "MCP" (the default), "SCAD", or "lasso".

**Value**

A list containing:

fitY	A fitted object from 'cv.ncvreg', containing the penalized regression results for 'Y'.
fitM2	The fitted reduced-rank regression ('sofar' or 'rrr' object) for 'M2' given 'M1'.
fitM3	The fitted reduced-rank regression ('sofar' or 'rrr' object) for 'M3' given 'M1' and 'M2'.
coefY	A vector of estimated regression coefficients for 'Y'.
coefM2	A matrix of estimated regression coefficients for 'M2' given 'M1'.
coefM3	A matrix of estimated regression coefficients for 'M3' given 'M1' and 'M2'.
rank1	An integer indicating the estimated rank of the reduced-rank regression for 'M2'.
rank2	An integer indicating the estimated rank of the reduced-rank regression for 'M3'.
P1	A projection matrix used to extract the orthogonal components of 'M1'.
P2	A projection matrix used to extract the orthogonal components of 'E2', which is the error term in the regression for 'M2' given 'M1'.

M1s A transformed version of ‘M1’ after projection.

M2s A transformed version of ‘M2’ after removing the effect of ‘M1’ and projecting to the orthogonal space.

M3s A transformed version of ‘M3’ after removing the effects of ‘M1’ and ‘M2’.

#' @references Dai, Z., Huang, Y. J., & Li, G. (2025). Multi-View Orthogonal Projection Regression with Application in Multi-omics Integration. arXiv preprint arXiv:2503.16807. Available at <<https://arxiv.org/abs/2503.16807>>

## Examples

```
## Simulation: three modalities
p1 = 50; p2 = 50; p3 = 50; n = 200
rank = 2

beta = c(rep(c(rep(1,5),rep(0,45)),3))
M1 = matrix(rnorm(p1*n),n,p1)

U1 = matrix(rnorm(rank*p1),p1,rank)
V1 = matrix(runif(rank*p2,-0.1,0.1),rank,p2)
B1 = U1 %>% V1

U2 = matrix(rnorm(rank*p1),p1,rank)
V2 = matrix(runif(rank*p2,-0.1,0.1),rank,p3)
B2 = U2 %>% V2

U3 = matrix(rnorm(rank*p2),p2,rank)
V3 = matrix(runif(rank*p2,-0.1,0.1),rank,p3)
B3 = U3 %>% V3

E1 = matrix(rnorm(p2*n),n,p2)
E2 = matrix(rnorm(p3*n),n,p3)

M2 = M1 %>% B1 + E1
M3 = M1 %>% B2 + M2 %>% B3 + E2
Y = cbind(M1,M2,M3) %>% matrix(beta,p1+p2+p3,1)

## Fit MVOPR with Lasso
Fit1 = MVOPR3(M1,M2,M3,Y,RRR_Control = list(Sparsity = FALSE),penalty = 'lasso')

## Fit MVOPR with MCP
Fit2 = MVOPR3(M1,M2,M3,Y,RRR_Control = list(Sparsity = FALSE),penalty = 'MCP')

## Fit MVOPR with SCAD
Fit3 = MVOPR3(M1,M2,M3,Y,RRR_Control = list(Sparsity = FALSE),penalty = 'SCAD')

## Compare the variable selection between Lasso, MCP, SCAD
print(data.frame(Lasso = Fit1$CoefY[2:151],MCP = Fit2$CoefY[2:151],SCAD = Fit3$CoefY[2:151],beta))
```

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