Package: sparsenet (via r-universe)

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Type Package

Title Fit Sparse Linear Regression Models via Nonconvex Optimization

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Description Efficient procedure for fitting regularization paths between L1 and L0, using the MC+ penalty of Zhang, C.H. (2010)<doi:10.1214/09-AOS729>. Implements the methodology described in Mazumder, Friedman and Hastie (2011) <DOI:10.1198/jasa.2011.tm09738>. Sparsenet computes the regularization surface over both the family parameter and the tuning parameter by coordinate descent.

Depends Matrix (>= 1.0-6), shape

Imports methods

License GPL-2

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`sparsenet-package` *Fit a linear model regularized by the nonconvex MC+ sparsity penalty*

Description

Sparsenet uses coordinate descent on the MC+ nonconvex penalty family, and fits a surface of solutions over the two-dimensional parameter space.

Details

At its simplest, provide `x,y` data and it returns the solution paths. There are tools for prediction, cross-validation, plotting and printing.

Author(s)

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References

Mazumder, Rahul, Friedman, Jerome and Hastie, Trevor (2011) *SparseNet: Coordinate Descent with Nonconvex Penalties. JASA, Vol 106(495), 1125-38*, https://hastie.su.domains/public/Papers/Sparsenet/Mazumder-SparseNetCoordinateDescent-2011.pdf

Examples

```
x=matrix(rnorm(100*20),100,20)
y=rnorm(100)
fit=sparsenet(x,y)
plot(fit)
cvfit=cv.sparsenet(x,y)
plot(cvfit)
```

cv.sparsenet *Cross-validation for sparsenet*

Description

Does k-fold cross-validation for sparsenet, produces a plot, and returns values for gamma, lambda

Usage

```
cv.sparsenet(x, y, weights, type.measure = c("mse", "mae"), ...,nfolds = 10,
       foldid, keep=FALSE, trace.it=FALSE)
```

Arguments

x	x matrix as in sparsenet.
y	response y as in sparsenet.
weights	Observation weights; defaults to 1 per observation
type.measure	loss to use for cross-validation. Currently two options: squared-error (type.measure="mse") or mean-absolute error (type.measure="mae")
...	Other arguments that can be passed to sparsenet.
nfolds	number of folds - default is 10. Although nfolds can be as large as the sample size (leave-one-out CV), it is not recommended for large datasets. Smallest value allowable is nfolds=3
foldid	an optional vector of values between 1 and nfold identifying whhat fold each observation is in. If supplied, nfold can be missing.
keep	If TRUE, we include the prevalidation array as component fit.preval on the returned object. Default is keep = FALSE.
trace.it	If TRUE, then we get a printout that shows the progress

Details

The function runs sparsenet nfolds+1 times; the first to get the lambda sequence, and then the remainder to compute the fit with each of the folds omitted. The error is accumulated, and the average error and standard deviation over the folds is computed.

Value

an object of class "cv.sparsenet" is returned, which is a list with the ingredients of the cross-validation fit.

lambda	the values of lambda used in the fits. This is an nlambda x ngamma matrix
cvm	The mean cross-validated error - a matrix shaped like lambda
cvsd	estimate of standard error of cvm.
cvup	upper curve = cvm+cvsd.

cvlo	lower curve = cvm-cvsd.
nzero	number of non-zero coefficients at each lambda, gamma pair.
name	a text string indicating type of measure (for plotting purposes).
sparsenet.fit	a fitted sparsenet object for the full data.
call	The call that produced this object
parms.min	values of gamma, lambda that gives minimum cvm.
which.min	indices for the above
lambda.1se	gamma, lambda of smallest model (df) such that error is within 1 standard error of the minimum.
which.1se	indices of the above

Author(s)

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References

Mazumder, Rahul, Friedman, Jerome and Hastie, Trevor (2011) *SparseNet: Coordinate Descent with Nonconvex Penalties. JASA, Vol 106(495), 1125-38*, https://hastie.su.domains/public/Papers/Sparsenet/Mazumder-SparseNetCoordinateDescent-2011.pdf

See Also

glmnet package, predict, coef, print and plot methods, and the sparsenet function.

Examples

```
train.data=gendata(100,1000,nonzero=30,rho=0.3,snr=3)
fit=sparsenet(train.data$x,train.data$y)
par(mfrow=c(3,3))
plot(fit)
par(mfrow=c(1,1))
fitcv=cv.sparsenet(train.data$x,train.data$y,trace.it=TRUE)
plot(fitcv)
```

---

gendata *Generate data for testing sparse model selection*

Description

This function generates x/y data for testing sparsenet and glmnet

Usage

```
gendata(N, p, nonzero, rho, snr = 3, alternate = TRUE)
```

Arguments

N	Sample size (eg 500)
p	Number of features or variables (eg 1000)
nonzero	Number if nonzero coefficients (eg 30)
rho	pairwise correlation between features
snr	Signal to noise ratio - SD signal/ SD noise - try 3
alternate	Alternate sign of coefficients

Details

Generates Gaussian x and y data. The nonzero coefficients decrease linearly in absolute value from nonzero down to 0. If `alternate=TRUE` their signs alternate, else not

Value

A list with components x and y as well some other details about the dataset

Author(s)

Trevor Hastie and Jerome Friedman

Examples

```
train.data=gendata(100,1000,nonzero=30,rho=0.3,snr=3)
fit=sparsenet(train.data$x,train.data$y)
par(mfrow=c(3,3))
plot(fit)
par(mfrow=c(1,1))
fitcv=cv.sparsenet(train.data$x,train.data$y,trace.it=TRUE)
plot(fitcv)
```

---

plot.cv.sparsenet *plot the cross-validation curves produced by cv.sparsenet*

Description

Plots the cross-validation curves for each value of gamma in one figure, as a function of the `lambda` values used.

Usage

```
## S3 method for class 'cv.sparsenet'
plot(x,  ...)
```

Arguments

x	fitted "cv.sparsenet" object
...	Other graphical parameters to plot

Details

A plot is produced, and nothing is returned.

Author(s)

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References

Mazumder, Rahul, Friedman, Jerome and Hastie, Trevor (2011) *SparseNet: Coordinate Descent with Nonconvex Penalties. JASA, Vol 106(495), 1125-38*, https://hastie.su.domains/public/Papers/Sparsenet/Mazumder-SparseNetCoordinateDescent-2011.pdf

See Also

glmnet package, sparsenet, cv.sparsenet and print and plot methods for both.

Examples

```
x=matrix(rnorm(100*20),100,20)
y=rnorm(100)
fitcv=cv.sparsenet(x,y)
plot(fitcv)
```

---

plot.sparsenet *plot coefficients from a "sparsenet" object*

Description

Produces a series of coefficient profile plots of the coefficient paths for a fitted "sparsenet" object.

Usage

```
## S3 method for class 'sparsenet'
plot(x, xvar = c("rsq","lambda","norm"), which.gamma=NULL, label = FALSE,...)
```

Arguments

x	fitted "sparsenet" model
xvar	What is on the X-axis. "rsq" plots against the percent variance explained on the training data, "lambda" against the log-lambda sequence, and "norm" plots against the L1-norm of the coefficients
which.gamma	sequence numbers of gamma values to be used in the plots; default is all used in the fit
label	If TRUE, label the curves with variable sequence numbers.
...	Other graphical parameters to plot

Details

A series of coefficient profile plots is produced, one for each gamma specified. Users should set up the appropriate layout.

Author(s)

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References

Mazumder, Rahul, Friedman, Jerome and Hastie, Trevor (2011) *SparseNet: Coordinate Descent with Nonconvex Penalties. JASA, Vol 106(495), 1125-38*, https://hastie.su.domains/public/Papers/Sparsenet/Mazumder-SparseNetCoordinateDescent-2011.pdf

See Also

glmnet package, sparsenet, cv.sparsenet and print and plot methods for both.

Examples

```
x=matrix(rnorm(100*20),100,20)
y=rnorm(100)
fit=sparsenet(x,y)
par(mfrow=c(3,3))
plot(fit)
```

`predict.cv.sparsenet` *make predictions from a "cv.sparsenet" object.*

Description

This function makes predictions from a cross-validated sparsenet model, using the stored `"sparsenet.fit"` object, and the optimal value chosen for `lambda`.

Usage

```
## S3 method for class 'cv.sparsenet'
predict(object, newx, which=c("parms.min","parms.1se"),...)
## S3 method for class 'cv.sparsenet'
coef(object, which=c("parms.min","parms.1se"),...)
```

Arguments

`object`	Fitted `"cv.sparsenet"` object.
`newx`	Matrix of new values for `x` at which predictions are to be made. Must be a matrix. See documentation for `predict.sparsenet`.
`which`	Either the paramaters of the minimum of the CV curves (default `"parms.min"` or the parameters corresponding to the one standard-error rule `parms.1se`)
`...`	Not used. Other arguments to predict.

Details

This function makes it easier to use the results of cross-validation to make a prediction.

Value

The object returned depends the ... argument which is passed on to the `predict` method for `sparsenet` objects.

Author(s)

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References

Mazumder, Rahul, Friedman, Jerome and Hastie, Trevor (2011) *SparseNet: Coordinate Descent with Nonconvex Penalties. JASA, Vol 106(495), 1125-38*, https://hastie.su.domains/public/Papers/Sparsenet/Mazumder-SparseNetCoordinateDescent-2011.pdf

See Also

`glmnet` package, `sparsenet`, `cv.sparsenet` and `print` and `plot` methods for both.

Examples

```
x=matrix(rnorm(100*20),100,20)
y=rnorm(100)
fitcv=cv.sparsenet(x,y)
predict(fitcv,x)
```

---

predict.sparsenet *make predictions from a "sparsenet" object.*

Description

Similar to other predict methods, this functions predicts fitted values, coefficients and more from a fitted "sparsenet" object.

Usage

```
## S3 method for class 'sparsenet'
predict(object, newx, s = NULL,  which.gamma = NULL,
type=c("response","coefficients","nonzero"), exact = FALSE, ...)
## S3 method for class 'sparsenet'
coef(object,s=NULL, which.gamma = NULL,exact=FALSE, ...)
```

Arguments

object	Fitted "sparsenet" model object.
newx	Matrix of new values for x at which predictions are to be made. Must be a matrix. This argument is not used for type=c("coefficients","nonzero")
s	Value(s) of the penalty parameter lambda at which predictions are required. Default is the entire sequence used to create the model.
which.gamma	Index or indices of gamma values at which predictions are to be made. Default is all those used in the fit
type	"response" returns fitted predictions at newx. Type "coefficients" computes the coefficients at the requested values for s. Type "nonzero" returns lists of the indices of the nonzero coefficients for each value of s.
exact	By default (exact=FALSE) the predict function uses linear interpolation to make predictions for values of s that do not coincide with those used in the fitting algorithm. Currently exact=TRUE is not implemented, but prints an error message telling the user how to achieve the exact predictions. This is done my rerunning the algorithm with the desired values interspersed (in order) with the values used in the original fit
...	Not used. Other arguments to predict.

Details

The shape of the objects returned depends on which which.gamma has more than one element. If more than one element, a list of predictions is returned, one for each gamma.

Value

The object returned depends on type.

Author(s)

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References

Mazumder, Rahul, Friedman, Jerome and Hastie, Trevor (2011) *SparseNet: Coordinate Descent with Nonconvex Penalties. JASA, Vol 106(495), 1125-38*, https://hastie.su.domains/public/Papers/Sparsenet/Mazumder-SparseNetCoordinateDescent-2011.pdf

See Also

`glmnet` package, `sparsenet`, `cv.sparsenet` and `print` and `plot` methods for both.

Examples

```
x=matrix(rnorm(100*20),100,20)
y=rnorm(100)
fit=sparsenet(x,y)
predict(fit, which.gamma=5,type="nonzero")
predict(fit,x)
```

---

sparsenet *Fit a linear model regularized by the nonconvex MC+ sparsity penalty*

Description

Sparsenet uses coordinate descent on the MC+ nonconvex penalty family, and fits a surface of solutions over the two-dimensional parameter space. This penalty family is indexed by an overall strength paramter lambda (like lasso), and a convexity parameter gamma. Gamma = infinity corresponds to the lasso, and gamma = 1 best subset.

Usage

```
sparsenet(x, y, weights, exclude, dfmax = nvars + 1, pmax = min(dfmax *2, nvars),
ngamma = 9, nlambda = 50, max.gamma = 150, min.gamma = 1.000001,
lambda.min.ratio = ifelse(nobs < nvars, 0.01, 1e-04), lambda = NULL,
gamma = NULL, parms = NULL, warm = c("lambda", "gamma", "both"),
thresh = 1e-05, maxit = 1e+06)
```

Arguments

x	Input matrix of nobs x nvars predictors
y	response vector
weights	Observation weights; default 1 for each observation
exclude	Indices of variables to be excluded from the model. Default is none.
dfmax	Limit the maximum number of variables in the model. Useful for very large nvars, if a partial path is desired.
pmax	Limit the maximum number of variables ever to be nonzero
ngamma	Number of gamma values, if gamma not supplied; default is 9.
nlambda	Number of lambda values, if lambda not supplied; default is 50
max.gamma	Largest gamma value to be used, apart from infinity (lasso), if gamma not supplied; default is 150
min.gamma	Smallest value of gamma to use, and should be >1; default is 1.000001
lambda.min.ratio	Smallest value for lambda, as a fraction of lambda.max, the (data derived) entry value (i.e. the smallest value for which all coefficients are zero). The default depends on the sample size nobs relative to the number of variables nvars. If nobs > nvars, the default is 0.0001, close to zero. If nobs < nvars, the default is 0.01. A very small value of lambda.min.ratio will lead to a saturated fit in the nobs < nvars case.
lambda	A user supplied lambda sequence, in decreasing order. Typical usage is to have the program compute its own lambda sequence based on nlambda and lambda.min.ratio. Supplying a value of lambda overrides this. WARNING: use with care. Do not supply a single value for lambda (for predictions after CV use predict() instead). Supply instead a decreasing sequence of lambda values. sparsenet relies on its warms starts for speed, and its often faster to fit a whole path than compute a single fit.
gamma	Sparsity parameter vector, with 1<gamma<infty. Gamma=1 corresponds to best-subset regression, gamma=infty to the lasso. Should be given in decreasing order.
parms	An optional three-dimensional array: 2x ngamma x nlambda. Here the user can supply exactly the gamma, lambda pairs that are to be traversed by the coordinate descent algorithm.
warm	How to traverse the grid. Default is "lambda", meaning warm starts from the previous lambda with the same gamma. "gamma" means the opposite, previous gamma for the same lambda. "both" tries both warm starts, and uses the one that improves the criterion the most.
thresh	Convergence threshold for coordinate descent. Each coordinate-descent loop continues until the maximum change in the objective after any coefficient update is less than thresh times the null Rss. Defaults value is 1E-5.
maxit	Maximum number of passes over the data for all lambda/gamma values; default is 10^6.

Details

This algorithm operates like `glmnet`, with its alpha parameter which moves the penalty between lasso and ridge; here gamma moves it between lasso and best subset. The algorithm traverses the two dimensional gamma/lambda array in a nested loop, with decreasing gamma in the outer loop, and decreasing lambda in the inner loop. Because of the nature of the MC+ penalty, each coordinate update is a convex problem, with a simple two-threshold shrinking scheme: beta< lambda set to zero; beta > lambda*gamma leave alone; beta inbetween, shrink proportionally. Note that this algorithm ALWAYS standardizes the columns of x and y to have mean zero and variance 1 (using the 1/N averaging) before it computes its fit. The coefficients reflect the original scale.

Value

An object of class `"sparsenet"`, with a number of components. Mostly one will access the components via generic functions like `coef()`, `plot()`, `predict()` etc.

`call`	the call that produced this object
`rsq`	The percentage variance explained on the training data; an ngamma x nlambda matrix.
`jerr`	error flag, for warnings and errors (largely for internal debugging).
`coefficients`	A coefficient list with ngamma elements; each of these is a coefficient list with various components: the matrix beta of coefficients, its dimension dim, the vector of intercepts, the lambda sequence, the gamma value, the sequence of df (nonzero coefficients) for each solution.
`parms`	Irrespective how the parameters were input, the three-way array of what was used.
`gamma`	The gamma values used
`lambda`	The lambda values used
`max.lambda`	The entry value for lambda

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References

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See Also

`glmnet` package, `predict`, `coef`, `print` and `plot` methods, and the `cv.sparsenet` function.

Examples

```
train.data=gendata(100,1000,nonzero=30,rho=0.3,snr=3)
fit=sparsenet(train.data$x,train.data$y)
par(mfrow=c(3,3))
plot(fit)
par(mfrow=c(1,1))
fitcv=cv.sparsenet(train.data$x,train.data$y,trace.it=TRUE)
plot(fitcv)
```

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