Package ‘ELMSO’

January 18, 2020

Type Package

Title Implementation of the Efficient Large-Scale Online Display Advertising Algorithm

Version 1.0.1

Date 2020-1-17

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Description An implementation of the algorithm described in “Efficient Large-Scale Internet Media Selection Optimization for Online Display Advertising” by Paulson, Luo, and James (Journal of Marketing Research 2018; see URL below for journal text/citation and <http://faculty.marshall.usc.edu/gareth-james/Research/ELMSO.pdf> for a full-text version of the paper). The algorithm here is designed to allocate budget across a set of online advertising opportunities using a coordinate-descent approach, but it can be used in any resource-allocation problem with a matrix of visitation (in the case of the paper, website page-views) and channels (in the paper, websites). The package contains allocation functions both in the presence of bidding, when allocation is dependent on channel-specific cost curves, and when advertising costs are fixed at each channel.

Depends R (>= 3.4.0)

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URL <https://journals.sagepub.com/doi/abs/10.1509/jmr.15.0307>

Repository CRAN

Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

NeedsCompilation no

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Date/Publication 2020-01-18 08:00:02 UTC
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ELMSO  Main ELMSO Function

Description

This function allows you to allocate budget to a set of websites based on the cost curve of the websites and a matrix of pageviews for those sites.

Usage

ELMSO(z, CPM = NULL, a = NULL, tau = NULL, step = 0.05,
size = 100, tol = 10^-3, iters = 200)

Arguments

z  An n by p matrix of pageviews

CPM  A p-dimensional vector of the average CPM values at each website. This is used to calculate the cost curve from a shifted logistic function. You may instead enter values for a p-dimensional "a" vector to define your own shifted logistic cost curve.

a  A p-dimensional vector of values controlling the steepness of the shifted logistic cost curve. You may instead enter values for a p-dimensional vector of average CPM values to have the curve calculated for you.

tau  A p-dimensional vector of total pageviews (in thousands) for each website. Defaults to the total pageviews in the matrix for each website (i.e., assumes z matrix represents all website pageviews) divided by 1000.

step  A value to control the step size of the lambda grid (distance between budget points). Default is 0.05.

size  A value to control the number of lambda values tried (number of budget points). Default is 100.

tol  A value to control the convergence tolerance of the coordinate descent procedure. Default is 10^-3.

iters  A value to control the number of iterations until algorithm should exit if convergence tolerance is not reached. Default is 200.
**Value**

- **bid**: A matrix of bid values by website at each budget
- **spend**: A matrix of total spend by website at each budget
- **budget**: A vector of budget values
- **lambda**: A vector of lambda values
- **a**: A vector of a values (used to calculate shifted logistic curves and reach in reach.ELMSO function)

**References**


**Examples**

```r
z = matrix(round(abs(rnorm(5000, 0, 0.7))), 1000, 5)
CPM.avg = c(3, 4, 5, 6, 7)
tau.values = rep(1000, 5) # Note tau here is in thousands of pageviews

allocation = ELMSO.fixed(z = z, CPM = CPM.avg, tau = tau.values)
allocation$bid
allocation$spend
allocation$budget
allocation$lambda
allocation$a
```

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**ELMSO.fixed**

**Fixed ELMSO Function (fixed advertising costs, no cost curve)**

**Description**

This function allows you to allocate budget to a set of websites when cost is fixed at each website based on a matrix of pageviews for those sites.

**Usage**

```r
ELMSO.fixed(z, CPM, tau = NULL, step = 0.05, size = 100,
             tol = 10^-3, iters = 200)
```

**Arguments**

- **z**: An n by p matrix of pageviews
- **CPM**: A p-dimensional vector of the (fixed) CPM values at each website
- **tau**: A p-dimensional vector of total pageviews (in thousands) for each website. Defaults to the total pageviews in the matrix for each website (i.e., assumes z matrix represents all website pageviews) divided by 1000.
step

A value to control the step size of the lambda grid (distance between budget points). Default is 0.05.

size

A value to control the number of lambda values tried (number of budget points). Default is 100.

tol

A value to control the convergence tolerance of the coordinate descent procedure. Default is 10^-3.

iters

A value to control the number of iterations until algorithm should exit if convergence tolerance is not reached. Default is 200.

Value

spend: a matrix of total spend by website at each budget

budget: a vector of budget values

lambda: a vector of lambda values

References


Examples

z=matrix(round(abs(rnorm(5000,0,0.7))),1000,5)
CPM.fixed=c(3,4,5,6,7)
tau.values=rep(100,5) #Note tau here is in thousands of pageviews

allocation=ELMSO.fixed(z=z,CPM=CPM.fixed,tau=tau.values)
allocation$spend
allocation$budget
allocation$lambda

reach.ELMSO

Calculating Reach from Main ELMSO Function

Description

This function allows you to calculate reach achieved at a given budget value from the ELMSO output.

Usage

reach.ELMSO(bid, a, z)
reach.ELMSO.fixed

Arguments

bid  A p-dimensional vector of the bidded CPM at each website for a particular budget value
a   A p-dimensional vector of steepness values for the cost curves associated with each website
z   An n by p matrix of pageviews

Value

A value between 0 and 1 specifying the reach achieved with the given budget allocation.

References


Examples

z=matrix(round(abs(rnorm(5000,0,0.7))),1000,5)
CPM.avg=c(3,4,5,6,7)
tau.values=rep(100,5)  #Note tau here is in thousands of pageviews
allocation=ELMSO(z=z,CPM=CPM.avg,tau=tau.values)
reach.ELMSO(allocation$bid[,101],allocation$a,z)

reach.ELMSO.fixed  Calculating Reach from Fixed ELMSO Function

Description

This function allows you to calculate reach achieved at a given budget value from the fixed ELMSO output.

Usage

reach.ELMSO.fixed(CPM, w, z, tau = NULL)

Arguments

CPM  A p-dimensional vector of the fixed CPM at each website for a particular budget value
w  A p-dimensional vector of amount spent at each website
z  An n by p matrix of pageviews
tau  A p-dimensional vector of total pageviews (in thousands) for each website. Defaults to the total pageviews in the matrix for each website (i.e., assumes z matrix represents all website pageviews) divided by 1000.
Value

A value between 0 and 1 specifying the reach achieved with the given budget allocation.

References


Examples

```r
z = matrix(round(abs(rnorm(5000, 0, 0.7))), 1000, 5)
CPM.fixed = c(3, 4, 5, 6, 7)
tau.values = rep(100, 5)  # Note tau here is in thousands of pageviews
allocation = ELMSO.fixed(z = z, CPM = CPM.fixed, tau = tau.values)
reach.ELMSO.fixed(CPM.fixed, allocation$spend[, 101], z, tau.values)
```
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