Package ‘LKT’

June 7, 2021

Title Logistic Knowledge Tracing

Version 1.0

Description Computes Logistic Knowledge Tracing ('LKT') which is a general method for tracking human learning in an educational software system. Please see Pavlik, Eglington, and Harrel-Williams (2021) <arXiv:2005.00869>. 'LKT' is a method to compute features of student data that are used as predictors of subsequent performance. 'LKT' allows great flexibility in the choice of predictive components and features computed for these predictive components. The system is built on top of 'LiblineaR', which enables extremely fast solutions compared to base glm() in R.

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Encoding UTF-8

LazyData true

VignetteBuilder knitr

RoxygenNote 7.1.1

Depends R (>= 3.5.0)

Imports lme4 (>= 1.1-23), pROC (>= 1.16.2), SparseM (>= 1.78), utils,
Matrix, methods, knitr, data.table (>= 1.13.2), LiblineaR (>= 2.10-8), glmnet (>= 4.0-2), glmnetUtils (>= 1.1.8), caret

NeedsCompilation no

Author Philip I. Pavlik Jr. [aut, ctb, cre]
(<https://orcid.org/0000-0001-6467-9452>),
Luke G. Eglington [aut, ctb] (<https://orcid.org/0000-0002-8432-9203>)

Maintainer Philip I. Pavlik Jr. <imrryr@gmail.com>

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Description

Compute feature describing prior practice effect.

Usage

```r
compute_features(data, feat, par1, par2, index, index2, par3, par4, par5, fcomp)
```

Arguments

- `data` copy of main data frame.
- `feat` is the feature to be computed.
- `par1` nonlinear parameters used for nonlinear features.
- `par2` nonlinear parameters used for nonlinear features.
- `index` a student by component levels index
- `index2` a component levels index
- `par3` nonlinear parameters used for nonlinear features.
- `par4` nonlinear parameters used for nonlinear features.
- `par5` nonlinear parameters used for nonlinear features.
- `fcomp` the component name.

Value

a vector suitable for regression input.
computeSpacingPredictors

**Description**

Compute repetition spacing time based features from input data CF..Time. and/or CF..reltime. which will be automatically computed from Duration..sec. if not present themselves.

**Usage**

```r
computeSpacingPredictors(data, KCs)
```

**Arguments**

- `data` is a dataset with Anon.Student.Id and CF..ansbin.
- `KCs` are the components for which spaced features will be specified in LKT

**Value**

Data which is the same frame with the added spacing relevant columns.

---

countOutcome

**Description**

Compute the prior sum of the response appearing in the outcome column for the index

**Usage**

```r
countOutcome(data, index, response)
```

**Arguments**

- `data` is the dataset to compute an outcome vector for
- `index` the subsets to count over
- `response` the actually response value being counted

**Value**

The vector of the lagged cumulative sum.
Description

Compute a logistic regression model of learning for input data.

Usage

LKT(
    data,
    components,
    features,
    fixedpars = NA,
    seedpars = NA,
    covariates = NA,
    dualfit = FALSE,
    interc = FALSE,
    cv = FALSE,
    elastic = FALSE,
    verbose = TRUE,
    epsilon = 1e-04,
    cost = 512,
    type = 0,
    maketimes = FALSE,
    bias = 0
)

Arguments

data A dataset with Anon.Student.Id and CF.ansbin.
components A vector of factors that can be used to compute each features for each subject.
features a vector methods to use to compute a feature for the component.
fixedpars a vector of parameters for all features+components.
seedpars a vector of parameters for all features+components to seed non-linear parameter search.
covariates A list of components that interacts with component by feature in the main specification.
dualfit TRUE or FALSE, fit a simple latency using logit.
interc TRUE or FALSE, include a global intercept.
cv TRUE or FALSE, if TRUE runs N-fold cv. Requires premade column named 'fold' with integers denoting the N folds
elastic glmnet, cv.glmnet, cva.glmnet or FALSE.
verbose provides more output in some cases.
epsilon passed to LiblineaR
cost passsed to LiblineaR
type passsed to LiblineaR
maketimes Boolean indicating whether to create time based features (or may be precomputed)
bias passsed to LiblineaR

Value
list of values "model", "coefs", "r2", "prediction", "nullmodel", "latencymodel", "optimizedpars", "subjectrmse", "newdata", and "loglike"

Examples

temp <- samplelkt
temp$CF..ansbin.<-ifelse(temp$Outcome=="CORRECT",1,ifelse(temp$Outcome=="INCORRECT",0,-1))
temp <- data.table::setDT(temp)
temp <- computeSpacingPredictors(temp, "KC..Default.")
temp <- temp[temp$CF..ansbin==0 | temp$CF..ansbin==1,]
temp$KC..Default.<-substr(temp$KC..Default.,1,10)
modelob <- LKT(
data = temp, interc=TRUE,
components = c("Anon.Student.Id", "KC..Default.", "KC..Default."),
features = c("logitdec", "logitdec", "lineafm"),
fixedpars = c(.9, .85)
)
print(modelob$coefs)
print(modelob$loglik)

modelob <- LKT(
data = temp, interc=TRUE,
components = c("Anon.Student.Id", "KC..Default.", "KC..Default."),
features = c("logitdec", "logitdec", "lineafm"),
seedpars = c(.9, .85)
)
print(modelob$coefs)
print(modelob$loglik)

modelob <- LKT(
data = temp, interc=TRUE,
components = c("Anon.Student.Id", "KC..Default.", "KC..Default."),
features = c("logitdec", "logitdec", "lineafm"),
fixedpars = c(.9, .85)
)
print(modelob$coefs)
print(modelob$loglik)

# this example illustrates how mean fit is worse for CV
# compared to the first example above. In this case,
# this is mainly do to the small dataset allowing overgeneralization
# despite the model only having 4 coefficients
```r
temp <- samplelkt
unq <- sample(unique(temp$Anon.Student.Id))
sfold <- rep(1:5, length.out=length(unq))
temp$fold <- rep(0, length(temp[,1]))
for(i in 1:5){temp$fold[which(temp$Anon.Student.Id %in% unq[which(sfold==i)])]=i}
modelob <- LKT(
  data = temp, interc=TRUE,
  components = c("Anon.Student.Id", "KC..Default.", "KC..Default."),
  features = c("logitdec", "logitdec", "lineafm"),
  fixedpars = c(.9, .85),cv=TRUE
)
print(modelob$cv_res)
print(mean(modelob$cv_res$rmse))
print(mean(modelob$cv_res$mcfad))

# this example illustrates the limitation of CV when data does not contain
# sufficient examples of each predictor
#modelob <- LKT(
#  data = temp, interc=TRUE,
#  components = c("Anon.Student.Id", "KC..Default.", "KC..Default."),
#  features = c("logitdec", "logitdec", "lineafm"),
#  fixedpars = c(.9, .85),cv=TRUE
#)
# print(modelob$cv_res)

# Trial sequences for practice participants.

samplelkt

Description

A dataset containing a small sample of participants in a memory experiment.

Usage

samplelkt

Format

A data frame with 2074 rows and many variables:

**Anon.Student.Id**  unique identifier for each student
**Duration..sec.** unique identifier for each student
**KC..Default.** unique identifier for each student
**Outcome**  unique identifier for each student ...

Source

http://datashop.memphis.edu/
```
Description
smallSet

Usage
smallSet(data, nSub)

Arguments
<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>data</td>
<td>Dataframe of student data</td>
</tr>
<tr>
<td>nSub</td>
<td>Number of students</td>
</tr>
</tbody>
</table>
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