

# Package ‘PatientLevelPrediction’

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**Type** Package

**Title** Package for patient level prediction using data in the OMOP Common Data Model

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**Author** Martijn J. Schuemie [aut, cre],  
Marc A. Suchard [aut],  
Patrick B. Ryan [aut]

**Maintainer** Martijn J. Schuemie <schuemie@ohdsi.org>

## Description

A package for creating patient level prediction models. Given a cohort of interest and an outcome of interest, the package can use data in the Common Data Model to build a large set of features. These features can then be used by the Cyclops package to fit a predictive model. Also included are function for evaluating the predictive models.

**License** Apache License 2.0

**Depends** R (>= 3.2.2),  
DatabaseConnector (>= 1.3.0),  
Cyclops (>= 1.2.0)

**Imports** ggplot2,  
bit,  
ff,  
ffbase (>= 0.12.1),  
plyr,  
survAUC,  
Rcpp (>= 0.11.2),  
RJDBC,  
SqlRender (>= 1.1.3),  
survival

**Suggests** testthat,  
pROC,  
gnm,  
knitr,  
rmarkdown,  
OhdsiRTools

**LinkingTo** Rcpp

**NeedsCompilation** yes

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---

byMaxFf

*Compute max of values binned by a second variable*

---

### Description

Compute max of values binned by a second variable

### Usage

```
byMaxFf(values, bins)
```

### Arguments

values	An ff object containing the numeric values to take the max of.
bins	An ff object containing the numeric values to bin by.

**Examples**

```
values <- ff::as.ff(c(1, 1, 2, 2, 1))
bins <- ff::as.ff(c(1, 1, 1, 2, 2))
byMaxFf(values, bins)
```

bySumFf

*Compute sum of values binned by a second variable***Description**

Compute sum of values binned by a second variable

**Usage**

```
bySumFf(values, bins)
```

**Arguments**

values	An ff object containing the numeric values to be summed
bins	An ff object containing the numeric values to bin by

**Examples**

```
values <- ff::as.ff(c(1, 1, 2, 2, 1))
bins <- ff::as.ff(c(1, 1, 1, 2, 2))
bySumFf(values, bins)
```

computeAuc

*Compute the area under the ROC curve***Description**

Compute the area under the ROC curve

**Usage**

```
computeAuc(prediction, plpData, removeDropoutsForLr = TRUE,
  confidenceInterval = FALSE)
```

**Arguments**

prediction	A prediction object as generated using the <a href="#">predictProbabilities</a> function.
plpData	An object of type plpData.
removeDropoutsForLr	If TRUE and modelType is "logistic", subjects that do not have the full observation window (i.e. are censored earlier) and do not have the outcome are removed prior to evaluating the model.
confidenceInterval	Should 95 percent confidence intervals be computed?

**Details**

Computes the area under the ROC curve for the predicted probabilities, given the true observed outcomes.

---

```
computeAucFromDataFrames
```

*Compute the area under the ROC curve*

---

**Description**

Compute the area under the ROC curve

**Usage**

```
computeAucFromDataFrames(prediction, status, time = NULL,
  confidenceInterval = FALSE, timePoint, modelType = "logistic")
```

**Arguments**

prediction	A vector with the predicted hazard rate.
status	A vector with the status of 1 (event) or 0 (no event).
time	Only for survival models: a vector with the time to event or censor (which ever comes first).
confidenceInterval	Should 95 percent confidence intervals be computed?
timePoint	Only for survival models: time point when the AUC should be evaluated
modelType	Type of model. Currently supported are "logistic" and "survival".

**Details**

Computes the area under the ROC curve for the predicted probabilities, given the true observed outcomes.

---

```
computeCovariateMeans
```

*Compute covariate means*

---

**Description**

Compute covariate means

**Usage**

```
computeCovariateMeans(plpData, cohortId = NULL, outcomeId = NULL)
```

**Arguments**

plpData	An object of type plpData.
cohortId	The ID of the specific cohort for which to compute the means.
outcomeId	The ID of the specific outcome for which to compute the subgroup means.

---

createCovariateSettings

*Create covariate settings*


---

## Description

Create covariate settings

## Usage

```
createCovariateSettings(useCovariateCohortIdIs1 = FALSE,
  useCovariateDemographics = TRUE, useCovariateDemographicsGender = TRUE,
  useCovariateDemographicsRace = TRUE,
  useCovariateDemographicsEthnicity = TRUE,
  useCovariateDemographicsAge = TRUE, useCovariateDemographicsYear = TRUE,
  useCovariateDemographicsMonth = TRUE,
  useCovariateConditionOccurrence = TRUE,
  useCovariateConditionOccurrence365d = TRUE,
  useCovariateConditionOccurrence30d = FALSE,
  useCovariateConditionOccurrenceInpt180d = FALSE,
  useCovariateConditionEra = FALSE, useCovariateConditionEraEver = FALSE,
  useCovariateConditionEraOverlap = FALSE,
  useCovariateConditionGroup = FALSE,
  useCovariateConditionGroupMeddra = FALSE,
  useCovariateConditionGroupSnomed = FALSE,
  useCovariateDrugExposure = FALSE, useCovariateDrugExposure365d = FALSE,
  useCovariateDrugExposure30d = FALSE, useCovariateDrugEra = FALSE,
  useCovariateDrugEra365d = FALSE, useCovariateDrugEra30d = FALSE,
  useCovariateDrugEraOverlap = FALSE, useCovariateDrugEraEver = FALSE,
  useCovariateDrugGroup = FALSE, useCovariateProcedureOccurrence = FALSE,
  useCovariateProcedureOccurrence365d = FALSE,
  useCovariateProcedureOccurrence30d = FALSE,
  useCovariateProcedureGroup = FALSE, useCovariateObservation = FALSE,
  useCovariateObservation365d = FALSE, useCovariateObservation30d = FALSE,
  useCovariateObservationCount365d = FALSE, useCovariateMeasurement = FALSE,
  useCovariateMeasurement365d = FALSE, useCovariateMeasurement30d = FALSE,
  useCovariateMeasurementCount365d = FALSE,
  useCovariateMeasurementBelow = FALSE,
  useCovariateMeasurementAbove = FALSE, useCovariateConceptCounts = FALSE,
  useCovariateRiskScores = FALSE, useCovariateRiskScoresCharlson = FALSE,
  useCovariateRiskScoresDCSI = FALSE, useCovariateRiskScoresCHADS2 = FALSE,
  useCovariateRiskScoresCHADS2VASc = FALSE,
  useCovariateInteractionYear = FALSE, useCovariateInteractionMonth = FALSE,
  excludedCovariateConceptIds = c(), includedCovariateConceptIds = c(),
  deleteCovariatesSmallCount = 100)
```

## Arguments

useCovariateCohortIdIs1

A boolean value (TRUE/FALSE) to determine if a covariate should be constructed for whether the cohort ID is 1 (currently primarily used in Cohort-Method).

`useCovariateDemographics`  
 A boolean value (TRUE/FALSE) to determine if demographic covariates (age in 5-yr increments, gender, race, ethnicity, year of index date, month of index date) will be created and included in future models.

`useCovariateDemographicsGender`  
 A boolean value (TRUE/FALSE) to determine if gender should be included in the model.

`useCovariateDemographicsRace`  
 A boolean value (TRUE/FALSE) to determine if race should be included in the model.

`useCovariateDemographicsEthnicity`  
 A boolean value (TRUE/FALSE) to determine if ethnicity should be included in the model.

`useCovariateDemographicsAge`  
 A boolean value (TRUE/FALSE) to determine if age (in 5 year increments) should be included in the model.

`useCovariateDemographicsYear`  
 A boolean value (TRUE/FALSE) to determine if calendar year should be included in the model.

`useCovariateDemographicsMonth`  
 A boolean value (TRUE/FALSE) to determine if calendar month should be included in the model.

`useCovariateConditionOccurrence`  
 A boolean value (TRUE/FALSE) to determine if covariates derived from `CONDITION_OCCURRENCE` table will be created and included in future models.

`useCovariateConditionOccurrence365d`  
 A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of condition in 365d window prior to or on cohort index date. Only applicable if `useCovariateConditionOccurrence = TRUE`.

`useCovariateConditionOccurrence30d`  
 A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of condition in 30d window prior to or on cohort index date. Only applicable if `useCovariateConditionOccurrence = TRUE`.

`useCovariateConditionOccurrenceInpt180d`  
 A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of condition within inpatient type in 180d window prior to or on cohort index date. Only applicable if `useCovariateConditionOccurrence = TRUE`.

`useCovariateConditionEra`  
 A boolean value (TRUE/FALSE) to determine if covariates derived from `CONDITION_ERA` table will be created and included in future models.

`useCovariateConditionEraEver`  
 A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of condition era anytime prior to or on cohort index date. Only applicable if `useCovariateConditionEra = TRUE`.

`useCovariateConditionEraOverlap`  
 A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of condition era that overlaps the cohort index date. Only applicable if `useCovariateConditionEra = TRUE`.

**useCovariateConditionGroup**

A boolean value (TRUE/FALSE) to determine if all CONDITION\_OCCURRENCE and CONDITION\_ERA covariates should be aggregated or rolled-up to higher-level concepts based on vocabulary classification.

**useCovariateConditionGroupMeddra**

A boolean value (TRUE/FALSE) to determine if all CONDITION\_OCCURRENCE and CONDITION\_ERA covariates should be aggregated or rolled-up to higher-level concepts based on the MEDDRA classification.

**useCovariateConditionGroupSnomed**

A boolean value (TRUE/FALSE) to determine if all CONDITION\_OCCURRENCE and CONDITION\_ERA covariates should be aggregated or rolled-up to higher-level concepts based on the SNOMED classification.

**useCovariateDrugExposure**

A boolean value (TRUE/FALSE) to determine if covariates derived from DRUG\_EXPOSURE table will be created and included in future models.

**useCovariateDrugExposure365d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of drug in 365d window prior to or on cohort index date. Only applicable if useCovariateDrugExposure = TRUE.

**useCovariateDrugExposure30d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of drug in 30d window prior to or on cohort index date. Only applicable if useCovariateDrugExposure = TRUE.

**useCovariateDrugEra**

A boolean value (TRUE/FALSE) to determine if covariates derived from DRUG\_ERA table will be created and included in future models.

**useCovariateDrugEra365d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of drug era in 365d window prior to or on cohort index date. Only applicable if useCovariateDrugEra = TRUE.

**useCovariateDrugEra30d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of drug era in 30d window prior to or on cohort index date. Only applicable if useCovariateDrugEra = TRUE.

**useCovariateDrugEraOverlap**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of drug era that overlaps the cohort index date. Only applicable if useCovariateDrugEra = TRUE.

**useCovariateDrugEraEver**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of drug era anytime prior to or on cohort index date. Only applicable if useCovariateDrugEra = TRUE.

**useCovariateDrugGroup**

A boolean value (TRUE/FALSE) to determine if all DRUG\_EXPOSURE and DRUG\_ERA covariates should be aggregated or rolled-up to higher-level concepts of drug classes based on vocabulary classification.

**useCovariateProcedureOccurrence**

A boolean value (TRUE/FALSE) to determine if covariates derived from PROCEDURE\_OCCURRENCE table will be created and included in future models.

**useCovariateProcedureOccurrence365d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of procedure in 365d window prior to or on cohort index date. Only applicable if useCovariateProcedureOccurrence = TRUE.

**useCovariateProcedureOccurrence30d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of procedure in 30d window prior to or on cohort index date. Only applicable if useCovariateProcedureOccurrence = TRUE.

**useCovariateProcedureGroup**

A boolean value (TRUE/FALSE) to determine if all PROCEDURE\_OCCURRENCE covariates should be aggregated or rolled-up to higher-level concepts based on vocabulary classification.

**useCovariateObservation**

A boolean value (TRUE/FALSE) to determine if covariates derived from OBSERVATION table will be created and included in future models.

**useCovariateObservation365d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of observation in 365d window prior to or on cohort index date. Only applicable if useCovariateObservation = TRUE.

**useCovariateObservation30d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of observation in 30d window prior to or on cohort index date. Only applicable if useCovariateObservation = TRUE.

**useCovariateObservationCount365d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for the count of each observation concept in 365d window prior to or on cohort index date. Only applicable if useCovariateObservation = TRUE.

**useCovariateMeasurement**

A boolean value (TRUE/FALSE) to determine if covariates derived from OBSERVATION table will be created and included in future models.

**useCovariateMeasurement365d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of measurement in 365d window prior to or on cohort index date. Only applicable if useCovariateMeasurement = TRUE.

**useCovariateMeasurement30d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of measurement in 30d window prior to or on cohort index date. Only applicable if useCovariateMeasurement = TRUE.

**useCovariateMeasurementCount365d**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for the count of each measurement concept in 365d window prior to or on cohort index date. Only applicable if useCovariateMeasurement = TRUE.

**useCovariateMeasurementBelow**

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of measurement with a numeric



value below normal range for latest value within 180d of cohort index. Only applicable if useCovariateMeasurement = TRUE (CDM v5+) or useCovariateObservation = TRUE (CDM v4).

useCovariateMeasurementAbove

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of measurement with a numeric value above normal range for latest value within 180d of cohort index. Only applicable if useCovariateMeasurement = TRUE (CDM v5+) or useCovariateObservation = TRUE (CDM v4).

useCovariateConceptCounts

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that count the number of concepts that a person has within each domain (CONDITION, DRUG, PROCEDURE, OBSERVATION)

useCovariateRiskScores

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that calculate various Risk Scores, including Charlson, DCSI.

useCovariateRiskScoresCharlson

A boolean value (TRUE/FALSE) to determine if the Charlson comorbidity index should be included in the model.

useCovariateRiskScoresDCSI

A boolean value (TRUE/FALSE) to determine if the DCSI score should be included in the model.

useCovariateRiskScoresCHADS2

A boolean value (TRUE/FALSE) to determine if the CHADS2 score should be included in the model.

useCovariateRiskScoresCHADS2VAsC

A boolean value (TRUE/FALSE) to determine if the CHADS2VAsC score should be included in the model.

useCovariateInteractionYear

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that represent interaction terms between all other covariates and the year of the cohort index date.

useCovariateInteractionMonth

A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that represent interaction terms between all other covariates and the month of the cohort index date.

excludedCovariateConceptIds

A list of concept IDs that should NOT be used to construct covariates.

includedCovariateConceptIds

A list of concept IDs that should be used to construct covariates.

deleteCovariatesSmallCount

A numeric value used to remove covariates that occur in both cohorts fewer than deleteCovariateSmallCounts time.

## Details

creates an object specifying how covariates should be constructed from data in the CDM model.

## Value

An object of type defaultCovariateSettings, to be used in other functions.

---

```
createHdpsCovariateSettings
```

*Create HDPS covariate settings*

---

## Description

Create HDPS covariate settings

## Usage

```
createHdpsCovariateSettings(useCovariateCohortIdIs1 = FALSE,
  useCovariateDemographics = TRUE, useCovariateDemographicsGender = TRUE,
  useCovariateDemographicsRace = TRUE,
  useCovariateDemographicsEthnicity = TRUE,
  useCovariateDemographicsAge = TRUE, useCovariateDemographicsYear = TRUE,
  useCovariateDemographicsMonth = TRUE,
  useCovariateConditionOccurrence = TRUE,
  useCovariate3DigitIcd9Inpatient180d = FALSE,
  useCovariate3DigitIcd9Inpatient180dMedF = FALSE,
  useCovariate3DigitIcd9Inpatient180d75F = FALSE,
  useCovariate3DigitIcd9Ambulatory180d = FALSE,
  useCovariate3DigitIcd9Ambulatory180dMedF = FALSE,
  useCovariate3DigitIcd9Ambulatory180d75F = FALSE,
  useCovariateDrugExposure = FALSE,
  useCovariateIngredientExposure180d = FALSE,
  useCovariateIngredientExposure180dMedF = FALSE,
  useCovariateIngredientExposure180d75F = FALSE,
  useCovariateProcedureOccurrence = FALSE,
  useCovariateProcedureOccurrenceInpatient180d = FALSE,
  useCovariateProcedureOccurrenceInpatient180dMedF = FALSE,
  useCovariateProcedureOccurrenceInpatient180d75F = FALSE,
  useCovariateProcedureOccurrenceAmbulatory180d = FALSE,
  useCovariateProcedureOccurrenceAmbulatory180dMedF = FALSE,
  useCovariateProcedureOccurrenceAmbulatory180d75F = FALSE,
  excludedCovariateConceptIds = c(), includedCovariateConceptIds = c(),
  deleteCovariatesSmallCount = 100)
```

## Arguments

useCovariateCohortIdIs1

A boolean value (TRUE/FALSE) to determine if a covariate should be constructed for whether the cohort ID is 1 (currently primarily used in Cohort-Method).

useCovariateDemographics

A boolean value (TRUE/FALSE) to determine if demographic covariates (age in 5-yr increments, gender, race, ethnicity, year of index date, month of index date) will be created and included in future models.

useCovariateDemographicsGender

A boolean value (TRUE/FALSE) to determine if gender should be included in the model.

useCovariateDemographicsRace	A boolean value (TRUE/FALSE) to determine if race should be included in the model.
useCovariateDemographicsEthnicity	A boolean value (TRUE/FALSE) to determine if ethnicity should be included in the model.
useCovariateDemographicsAge	A boolean value (TRUE/FALSE) to determine if age (in 5 year increments) should be included in the model.
useCovariateDemographicsYear	A boolean value (TRUE/FALSE) to determine if calendar year should be included in the model.
useCovariateDemographicsMonth	A boolean value (TRUE/FALSE) to determine if calendar month should be included in the model.
useCovariateConditionOccurrence	A boolean value (TRUE/FALSE) to determine if covariates derived from CONDITION_OCCURRENCE table will be created and included in future models.
useCovariate3DigitIcd9Inpatient180d	A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of condition within inpatient setting in 180d window prior to or on cohort index date. Conditions are aggregated at the ICD-9 3-digit level. Only applicable if useCovariateConditionOccurrence = TRUE.
useCovariate3DigitIcd9Inpatient180dMedF	Similar to useCovariate3DigitIcd9Inpatient180d, but now only if the frequency of the ICD-9 code is higher than the median.
useCovariate3DigitIcd9Inpatient180d75F	Similar to useCovariate3DigitIcd9Inpatient180d, but now only if the frequency of the ICD-9 code is higher than the 75th percentile.
useCovariate3DigitIcd9Ambulatory180d	A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of condition within ambulatory setting in 180d window prior to or on cohort index date. Conditions are aggregated at the ICD-9 3-digit level. Only applicable if useCovariateConditionOccurrence = TRUE.
useCovariate3DigitIcd9Ambulatory180dMedF	Similar to useCovariate3DigitIcd9Ambulatory180d, but now only if the frequency of the ICD-9 code is higher than the median.
useCovariate3DigitIcd9Ambulatory180d75F	Similar to useCovariate3DigitIcd9Ambulatory180d, but now only if the frequency of the ICD-9 code is higher than the 75th percentile.
useCovariateDrugExposure	A boolean value (TRUE/FALSE) to determine if covariates derived from DRUG_EXPOSURE table will be created and included in future models.
useCovariateIngredientExposure180d	A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of drug ingredients within inpatient setting in 180d window prior to or on cohort index date. Only applicable if useCovariateDrugExposure = TRUE.

useCovariateIngredientExposure180dMedF	Similar to useCovariateIngredientExposure180d, but now only if the frequency of the ingredient is higher than the median.
useCovariateIngredientExposure180d75F	Similar to useCovariateIngredientExposure180d, but now only if the frequency of the ingredient is higher than the 75th percentile.
useCovariateProcedureOccurrence	A boolean value (TRUE/FALSE) to determine if covariates derived from PROCEDURE_OCCURRENCE table will be created and included in future models.
useCovariateProcedureOccurrenceInpatient180d	A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of procedures within inpatient setting in 180d window prior to or on cohort index date. Only applicable if useCovariateProcedureOccurrence = TRUE.
useCovariateProcedureOccurrenceInpatient180dMedF	Similar to useCovariateProcedureOccurrenceInpatient180d, but now only if the frequency of the procedure code is higher than the median.
useCovariateProcedureOccurrenceInpatient180d75F	Similar to useCovariateProcedureOccurrenceInpatient180d, but now only if the frequency of the procedure code is higher than the 75th percentile.
useCovariateProcedureOccurrenceAmbulatory180d	A boolean value (TRUE/FALSE) to determine if covariates will be created and used in models that look for presence/absence of procedures within ambulatory setting in 180d window prior to or on cohort index date. Only applicable if useCovariateProcedureOccurrence = TRUE.
useCovariateProcedureOccurrenceAmbulatory180dMedF	Similar to useCovariateProcedureOccurrenceAmbulatory180d, but now only if the frequency of the procedure code is higher than the median.
useCovariateProcedureOccurrenceAmbulatory180d75F	Similar to useCovariateProcedureOccurrenceAmbulatory180d, but now only if the frequency of the procedure code is higher than the 75th percentile.
excludedCovariateConceptIds	A list of concept IDs that should NOT be used to construct covariates.
includedCovariateConceptIds	A list of concept IDs that should be used to construct covariates.
deleteCovariatesSmallCount	A numeric value used to remove covariates that occur in both cohorts fewer than deleteCovariateSmallCounts time.

## Details

creates an object specifying how covariates should be constructed from data in the CDM model.

## Value

An object of type HdpsCovariateSettings, to be used in other functions.

---

```
createPIPSimulationProfile
```

*Create simulation profile*

---

### Description

createPlpDataSimulationProfile creates a profile based on the provided plpData object, which can be used to generate simulated data that has similar characteristics.

### Usage

```
createPIPSimulationProfile(plpData)
```

### Arguments

plpData            An object of type plpData as generated using getDbplpData.

### Details

The output of this function is an object that can be used by the simulatePlpData function to generate a plpData object.

### Value

An object of type plpDataSimulationProfile.

---

```
createTextCovariateSettings
```

*Create text covariate settings*

---

### Description

Create text covariate settings

### Usage

```
createTextCovariateSettings(language = "eng", removeNegations = TRUE,  
  deleteCovariatesSmallCount = 100)
```

### Arguments

language            Specify the language of the free-text.

removeNegations    Remove negated text prior to constructing features.

deleteCovariatesSmallCount    A numeric value used to remove covariates that occur in both cohorts fewer than deleteCovariateSmallCounts time.

**Details**

creates an object specifying how covariates should be constructed from text in notes table in the CDM model.

**Value**

An object of type covariateSettings, to be used in other functions.

---

exportPlpDataToCsv	<i>Export all data in a plpData object to CSV files</i>
--------------------	---

---

**Description**

Export all data in a plpData object to CSV files

**Usage**

```
exportPlpDataToCsv(plpData, outputFolder)
```

**Arguments**

plpData	An object of type plpData.
outputFolder	The folder on the file system where the CSV files will be created. If the folder does not yet exist it will be created.

**Details**

Created a set of CSV files in the output folder with all the data in the plpData object. This function is intended to be used for research into prediction methods. The following files will be created:

**cohort.csv** Listing all persons and their prediction periods. This file will have these fields: row\_id (a unique ID per period), person\_id, cohort\_start\_date, cohort\_id, time (number of days in the window).

**outcomes.csv** Listing all outcomes per period. This file will have these fields: row\_id, outcome\_id, outcome\_count, time\_to\_event.

**exclude.csv** Either not exported or a file listing per outcome ID which windows had the outcome prior to the window and should therefore be removed prior to fitting the model. This object will have these fields: rowId, outcomeId.

**covariates.csv** Listing the baseline covariates per person in the cohorts. This is done using a sparse representation: covariates with a value of 0 are omitted to save space. The covariates file will have three columns: rowId, covariateId, and covariateValue.

**covariateRef.csv** A file describing the covariates that have been extracted.

**metaData** Some information on how the plpData object was constructed.

**Examples**

```
## Not run:
exportPlpDataToCsv(plpData, "s:/temp/exportTest")

## End(Not run)
```

---

fitPredictiveModel	<i>Fit a predictive model</i>
--------------------	-------------------------------

---

## Description

Fit a predictive model

## Usage

```
fitPredictiveModel(plpData, modelType = "logistic",
  removeDropoutsForLr = TRUE, cohortId = NULL, outcomeId = NULL,
  prior = createPrior("laplace", exclude = c(0), useCrossValidation = TRUE),
  control = createControl(noiseLevel = "silent", cvType = "auto",
    startingVariance = 0.1))
```

## Arguments

plpData	An object of type plpData.
modelType	The type of predictive model. Options are "logistic", "poisson", and "survival".
removeDropoutsForLr	If TRUE and modelType is "logistic", subjects that do not have the full observation window (i.e. are censored earlier) and do not have the outcome are removed prior to fitting the model.
cohortId	The ID of the specific cohort for which to fit a model.
outcomeId	The ID of the specific outcome for which to fit a model.
prior	The prior used to fit the model. See <a href="#">createPrior</a> for details.
control	The control object used to control the cross-validation used to determine the hyperparameters of the prior (if applicable). See <a href="#">createControl</a> for details.

---

getDbCovariateData	<i>Get covariate information from the database</i>
--------------------	--

---

## Description

Uses one or several covariate builder functions to construct covariates.

## Usage

```
getDbCovariateData(connection, oracleTempSchema = NULL, cdmDatabaseSchema,
  cdmVersion = "4", cohortTempTable = "cohort_person",
  rowIdField = "subject_id", covariateSettings, normalize = TRUE)
```

## Arguments

connection	A connection to the server containing the schema as created using the connect function in the DatabaseConnector package.
oracleTempSchema	A schema where temp tables can be created in Oracle.
cdmDatabaseSchema	The name of the database schema that contains the OMOP CDM instance. Requires read permissions to this database. On SQL Server, this should specify both the database and the schema, so for example 'cdm_instance.dbo'.
cdmVersion	Define the OMOP CDM version used: currently support "4" and "5".
cohortTempTable	Name of the temp table holding the cohort for which we want to construct covariates
rowIdField	The name of the field in the cohort temp table that is to be used as the row_id field in the output table. This can be especially usefull if there is more than one period per person.
covariateSettings	Either an object of type covariateSettings as created using one of the createCovariate functions, or a list of such objects.
normalize	Should covariate values be normalized? If true, values will be divided by the max value per covariate.

## Details

This function uses the data in the CDM to construct a large set of covariates for the provided cohort. The cohort is assumed to be in an existing temp table with these fields: 'subject\_id', 'cohort\_definition\_id', 'cohort\_start\_date'. Optionally, an extra field can be added containing the unique identifier that will be used as rowID in the output. This function is called automatically by the [getDbPlpData](#) function.

## Value

Returns an object of type covariateData, containing information on the baseline covariates. Information about multiple outcomes can be captured at once for efficiency reasons. This object is a list with the following components:

**covariates** An ffdF object listing the baseline covariates per person in the cohorts. This is done using a sparse representation: covariates with a value of 0 are omitted to save space. The covariates object will have three columns: rowId, covariateId, and covariateValue. The rowId is usually equal to the person\_id, unless specified otherwise in the rowIdField argument.

**covariateRef** An ffdF object describing the covariates that have been extracted.

**metaData** A list of objects with information on how the covariateData object was constructed.



---

getDbDefaultCovariateData

*Get default covariate information from the database*


---

## Description

Constructs a large default set of covariates for one or more cohorts using data in the CDM schema. Includes covariates for all drugs, drug classes, condition, condition classes, procedures, observations, etc.

## Usage

```
getDbDefaultCovariateData(connection, oracleTempSchema = NULL,
  cdmDatabaseSchema, cdmVersion = "4", cohortTempTable = "cohort_person",
  rowIdField = "subject_id", covariateSettings)
```

## Arguments

connection	A connection to the server containing the schema as created using the connect function in the DatabaseConnector package.
oracleTempSchema	A schema where temp tables can be created in Oracle.
cdmDatabaseSchema	The name of the database schema that contains the OMOP CDM instance. Requires read permissions to this database. On SQL Server, this should specify both the database and the schema, so for example 'cdm_instance.dbo'.
cdmVersion	Define the OMOP CDM version used: currently support "4" and "5".
cohortTempTable	Name of the temp table holding the cohort for which we want to construct covariates
rowIdField	The name of the field in the cohort temp table that is to be used as the row_id field in the output table. This can be especially usefull if there is more than one period per person.
covariateSettings	An object of type defaultCovariateSettings as created using the <a href="#">createCovariateSettings</a> function.

## Details

This function uses the data in the CDM to construct a large set of covariates for the provided cohort. The cohort is assumed to be in an existing temp table with these fields: 'subject\_id', 'cohort\_definition\_id', 'cohort\_start\_date'. Optionally, an extra field can be added containing the unique identifier that will be used as rowID in the output. This function is called automatically by the [getDbPlpData](#) function.

## Value

Returns an object of type covariateData, containing information on the baseline covariates. Information about multiple outcomes can be captured at once for efficiency reasons. This object is a list with the following components:

**covariates** An ffdof object listing the baseline covariates per person in the cohorts. This is done using a sparse representation: covariates with a value of 0 are omitted to save space. The covariates object will have three columns: rowId, covariateId, and covariateValue. The rowId is usually equal to the person\_id, unless specified otherwise in the rowIdField argument.

**covariateRef** An ffdof object describing the covariates that have been extracted.

**metaData** A list of objects with information on how the covariateData object was constructed.

---

getDbHdpsCovariateData

*Get HDPS covariate information from the database*

---

## Description

Constructs the set of covariates for one or more cohorts using data in the CDM schema. This implements the covariates typically used in the HDPS algorithm.

## Usage

```
getDbHdpsCovariateData(connection, oracleTempSchema = NULL, cdmDatabaseSchema,
  cdmVersion = "4", cohortTempTable = "cohort_person",
  rowIdField = "subject_id", covariateSettings)
```

## Arguments

connection	A connection to the server containing the schema as created using the connect function in the DatabaseConnector package.
oracleTempSchema	A schema where temp tables can be created in Oracle.
cdmDatabaseSchema	The name of the database schema that contains the OMOP CDM instance. Requires read permissions to this database. On SQL Server, this should specify both the database and the schema, so for example 'cdm_instance.dbo'.
cdmVersion	Define the OMOP CDM version used: currently support "4" and "5".
cohortTempTable	Name of the temp table holding the cohort for which we want to construct covariates
rowIdField	The name of the field in the cohort temp table that is to be used as the row_id field in the output table. This can be especially useful if there is more than one period per person.
covariateSettings	An object of type covariateSettings as created using the <a href="#">createHdpsCovariateSettings</a> function.

## Details

This function uses the data in the CDM to construct a large set of covariates for the provided cohort. The cohort is assumed to be in an existing temp table with these fields: 'subject\_id', 'cohort\_definition\_id', 'cohort\_start\_date'. Optionally, an extra field can be added containing the unique identifier that will be used as rowID in the output. This function is called automatically by the [getDbPlpData](#) function.

**Value**

Returns an object of type `covariateData`, containing information on the baseline covariates. Information about multiple outcomes can be captured at once for efficiency reasons. This object is a list with the following components:

**covariates** An `ffdf` object listing the baseline covariates per person in the cohorts. This is done using a sparse representation: covariates with a value of 0 are omitted to save space. The covariates object will have three columns: `rowId`, `covariateId`, and `covariateValue`. The `rowId` is usually equal to the `person_id`, unless specified otherwise in the `rowIdField` argument.

**covariateRef** An `ffdf` object describing the covariates that have been extracted.

**metaData** A list of objects with information on how the `covariateData` object was constructed.

---

<code>getDbPlpData</code>	<i>Get outcomes for persons in the cohort</i>
---------------------------	---

---

**Description**

Get all the data for the prediction problem from the server.

**Usage**

```
getDbPlpData(connectionDetails = NULL, cdmDatabaseSchema,
  oracleTempSchema = NULL, cohortDatabaseSchema = cdmDatabaseSchema,
  cohortTable = "cohort", cohortIds = c(0, 1), washoutWindow = 183,
  useCohortEndDate = TRUE, windowPersistence = 0, covariateSettings,
  outcomeDatabaseSchema = cdmDatabaseSchema,
  outcomeTable = "condition_occurrence", outcomeIds = c(),
  outcomeConditionTypeConceptIds = "", firstOutcomeOnly = FALSE,
  cdmVersion = "4")
```

**Arguments**

`connectionDetails`

An R object of type `connectionDetails` created using the function `createConnectionDetails` in the `DatabaseConnector` package.

`cdmDatabaseSchema`

The name of the database schema that contains the OMOP CDM instance. Requires read permissions to this database. On SQL Server, this should specify both the database and the schema, so for example `'cdm_instance.dbo'`.

`oracleTempSchema`

A schema where temp tables can be created in Oracle.

`cohortDatabaseSchema`

Where is the source cohort table located? Note that on SQL Server, one should include both the database and schema, e.g. `"cdm_schema.dbo"`.

`cohortTable`

What is the name of the table holding the cohort?

`cohortIds`

The IDs of the cohorts for which we want to create models.

`washoutWindow`

The minimum required continuous observation time prior to index date for a person to be included in the cohort.

useCohortEndDate	Use the cohort end date as the basis for the end of the risk window? If FALSE, the cohort start date will be used instead.
windowPersistence	The number of days the risk window should persist.
covariateSettings	An object of type covariateSettings as created using the <a href="#">createCovariateSettings</a> function.
outcomeDatabaseSchema	The name of the database schema that is the location where the data used to define the outcome cohorts is available. If outcomeTable = CONDITION_ERA, outcomeDatabaseSchema is not used. Requires read permissions to this database.
outcomeTable	The tablename that contains the outcome cohorts. If outcomeTable <> CONDITION_OCCURRENCE, then expectation is outcomeTable has format of COHORT table: COHORT_CONCEPT_ID, SUBJECT_ID, COHORT_START_DATE, COHORT_END_DATE.
outcomeIds	A list of ids used to define outcomes. If outcomeTable = CONDITION_OCCURRENCE, the list is a set of ancestor CONCEPT_IDs, and all occurrences of all descendant concepts will be selected. If outcomeTable <> CONDITION_OCCURRENCE, the list contains records found in COHORT_DEFINITION_ID field.
outcomeConditionTypeConceptIds	A list of TYPE_CONCEPT_ID values that will restrict condition occurrences. Only applicable if outcomeTable = CONDITION_OCCURRENCE.
firstOutcomeOnly	Only keep the first outcome per person?
cdmVersion	Define the OMOP CDM version used: currently support "4" and "5".

## Details

For the specified cohorts, retrieve the outcomes of interest and covariates to be used for the prediction problem.

## Value

An object of type plpData containing information on the prediction problem. This object will contain the following data:

**cohorts** An ffd object listing all persons and their prediction periods. This object will have these fields: row\_id (a unique ID per period), person\_id, cohort\_start\_date, cohort\_id, time (number of days in the window).

**outcomes** An ffd object listing all outcomes per period. This object will have these fields: row\_id, outcome\_id, outcome\_count, time\_to\_event.

**exclude** Either NULL or an ffd object listing per outcome ID which windows had the outcome prior to the window. This object will have these fields: rowId, outcomeId.

**covariates** An ffd object listing the baseline covariates per person in the cohorts. This is done using a sparse representation: covariates with a value of 0 are omitted to save space. The covariates object will have three columns: rowId, covariateId, and covariateValue.

**covariateRef** An ffd object describing the covariates that have been extracted.

**metaData** A list of objects with information on how the plpData object was constructed.

---

getDbTextCovariateData

*Get text covariate information from the database*


---

## Description

Uses a bag-of-words approach to construct covariates based on free-text.

## Usage

```
getDbTextCovariateData(connection, oracleTempSchema = NULL, cdmDatabaseSchema,
  cdmVersion = "4", cohortTempTable = "cohort_person",
  rowIdField = "subject_id", covariateSettings)
```

## Arguments

connection	A connection to the server containing the schema as created using the connect function in the DatabaseConnector package.
oracleTempSchema	A schema where temp tables can be created in Oracle.
cdmDatabaseSchema	The name of the database schema that contains the OMOP CDM instance. Requires read permissions to this database. On SQL Server, this should specify both the database and the schema, so for example 'cdm_instance.dbo'.
cdmVersion	Define the OMOP CDM version used: currently support "4" and "5".
cohortTempTable	Name of the temp table holding the cohort for which we want to construct covariates
rowIdField	The name of the field in the cohort temp table that is to be used as the row_id field in the output table. This can be especially usefull if there is more than one period per person.
covariateSettings	An object of type covariateSettings as created using the <a href="#">createTextCovariateSettings</a> function.

## Details

This function uses the data in the CDM to construct a large set of covariates for the provided cohort. The cohort is assumed to be in an existing temp table with these fields: 'subject\_id', 'cohort\_definition\_id', 'cohort\_start\_date'. Optionally, an extra field can be added containing the unique identifier that will be used as rowID in the output. This function is called automatically by the [getDbPlpData](#) function.

## Value

Returns an object of type covariateData, containing information on the baseline covariates. Information about multiple outcomes can be captured at once for efficiency reasons. This object is a list with the following components:

**covariates** An ffdF object listing the baseline covariates per person in the cohorts. This is done using a sparse representation: covariates with a value of 0 are omitted to save space. The covariates object will have three columns: rowId, covariateId, and covariateValue. The rowId is usually equal to the person\_id, unless specified otherwise in the rowIdField argument.

**covariateRef** An ffdF object describing the covariates that have been extracted.

**metaData** A list of objects with information on how the covariateData object was constructed.

---

getModelDetails	<i>Get the predictive model details</i>
-----------------	---

---

### Description

getModelDetails shows the full model, so showing the betas of all variables included in the model, along with the variable names

### Usage

```
getModelDetails(predictiveModel, plpData)
```

### Arguments

predictiveModel	An object of type predictiveModel as generated using the <a href="#">fitPredictiveModel</a> function.
plpData	An object of type plpData as generated using <a href="#">getDbPlpData</a> .

### Details

Shows the coefficients and names of the covariates with non-zero coefficients.

---

loadCovariateData	<i>Load the covariate data from a folder</i>
-------------------	--

---

### Description

loadCovariateData loads an object of type covariateData from a folder in the file system.

### Usage

```
loadCovariateData(file, readOnly = FALSE)
```

### Arguments

file	The name of the folder containing the data.
readOnly	If true, the data is opened read only.

### Details

The data will be written to a set of files in the folder specified by the user.

**Value**

An object of class covariateData

**Examples**

```
# todo
```

---

loadPlpData

*Load the PatientLevelPrediction data from a folder*


---

**Description**

loadPlpData loads an object of type plpData from a folder in the file system.

**Usage**

```
loadPlpData(file, readOnly = FALSE)
```

**Arguments**

file	The name of the folder containing the data.
readOnly	If true, the data is opened read only.

**Details**

The data will be written to a set of files in the folder specified by the user.

**Value**

An object of class PIPData

**Examples**

```
# todo
```

---

normalizeCovariates

*Normalize covariate values*


---

**Description**

Normalize covariate values

**Usage**

```
normalizeCovariates(covariates)
```

**Arguments**

covariates	An ffdF object as generated using the <a href="#">getDbCovariateData</a> function. #'
------------	---

**Details**

Normalize covariate values by dividing by the max. This is to avoid numeric problems when fitting models.

---

PatientLevelPrediction

*PatientLevelPrediction*


---

**Description**

PatientLevelPrediction

---

plotCalibration

*Plot the calibration*


---

**Description**

Plot the calibration

**Usage**

```
plotCalibration(prediction, plpData, removeDropoutsForLr = TRUE,
  numberOfStrata = 5, truncateFraction = 0.01, fileName = NULL)
```

**Arguments**

prediction	A prediction object as generated using the <a href="#">predictProbabilities</a> function.
plpData	An object of type plpData.
removeDropoutsForLr	If TRUE and modelType is "logistic", subjects that do not have the full observation window (i.e. are censored earlier) and do not have the outcome are removed prior to evaluating the model.
numberOfStrata	The number of strata in the plot.
truncateFraction	This fraction of probability values will be ignored when plotting, to avoid the x-axis scale being dominated by a few outliers.
fileName	Name of the file where the plot should be saved, for example 'plot.png'. See the function ggsave in the ggplot2 package for supported file formats.

**Details**

Create a plot showing the predicted probabilities and the observed fractions. Predictions are stratified into equally sized bins of predicted probabilities.

**Value**

A ggplot object. Use the [ggsave](#) function to save to file in a different format.



---

```
plotCovariateDifferenceOfTopVariables
```

*Plot variables with largest standardized difference*

---

**Description**

Create a plot showing those variables having the largest standardized difference between the group having the outcome and the group that doesn't have the outcome. Requires running `computeCovariateMeans` first.

**Usage**

```
plotCovariateDifferenceOfTopVariables(means, n = 20, maxNameWidth = 100,
  fileName = NULL)
```

**Arguments**

<code>means</code>	A data frame created by the <code>computeCovariateMeans</code> function.
<code>n</code>	Count of variates to plot.
<code>maxNameWidth</code>	Covariate names longer than this number of characters are truncated to create a nicer plot.
<code>fileName</code>	Name of the file where the plot should be saved, for example 'plot.png'. See the function <code>ggsave</code> in the <code>ggplot2</code> package for supported file formats.

**Value**

A ggplot object. Use the [ggsave](#) function to save to file in a different format.

---

```
plotRoc
```

*Plot the ROC curve*

---

**Description**

Plot the ROC curve

**Usage**

```
plotRoc(prediction, plpData, removeDropoutsForLr = TRUE, fileName = NULL)
```

**Arguments**

<code>prediction</code>	A prediction object as generated using the <a href="#">predictProbabilities</a> function.
<code>plpData</code>	An object of type <code>plpData</code> .
<code>removeDropoutsForLr</code>	If TRUE and <code>modelType</code> is "logistic", subjects that do not have the full observation window (i.e. are censored earlier) and do not have the outcome are removed prior to evaluating the model.
<code>fileName</code>	Name of the file where the plot should be saved, for example 'plot.png'. See the function <code>ggsave</code> in the <code>ggplot2</code> package for supported file formats.

**Details**

Create a plot showing the Receiver Operator Characteristics (ROC) curve.

**Value**

A ggplot object. Use the [ggsave](#) function to save to file in a different format.

---

plpDataSimulationProfile

*A simulation profile*

---

**Description**

A simulation profile

**Usage**

```
data(plpDataSimulationProfile)
```

---

predictFfdf

*Generated predictions from a regression model*

---

**Description**

Generated predictions from a regression model

**Usage**

```
predictFfdf(coefficients, outcomes, covariates, modelType = "logistic")
```

**Arguments**

coefficients	A names numeric vector where the names are the covariateIds, except for the first value which is expected to be the intercept.
outcomes	A data frame or ffdF object containing the outcomes with predefined columns (see below).
covariates	A data frame or ffdF object containing the covariates with predefined columns (see below).
modelType	Current supported types are "logistic", "poisson", or "survival".

**Details**

These columns are expected in the outcome object:

rowId	(integer)	Row ID is used to link multiple covariates (x) to a single outcome (y)
time	(real)	For models that use time (e.g. Poisson or Cox regression) this contains time (e.g. number of days)

These columns are expected in the covariates object:

rowId	(integer)	Row ID is used to link multiple covariates (x) to a single outcome (y)
covariateId	(integer)	A numeric identifier of a covariate
covariateValue	(real)	The value of the specified covariate

---

predictProbabilities    *Create predictive probabilities*

---

## Description

Create predictive probabilities

## Usage

```
predictProbabilities(predictiveModel, plpData)
```

## Arguments

predictiveModel	An object of type predictiveModel as generated using <a href="#">fitPredictiveModel</a> .
plpData	An object of type plpData as generated using <a href="#">getDbPlpData</a> .

## Details

Generates predictions for the population specified in plpData given the model.

## Value

The value column in the result data.frame is: logistic: probabilities of the outcome, poisson: Poisson rate (per day) of the outcome, survival: hazard rate (per day) of the outcome.

---

saveCovariateData    *Save the covariate data to folder*

---

## Description

saveCovariateData saves an object of type covariateData to folder.

## Usage

```
saveCovariateData(covariateData, file)
```

## Arguments

covariateData	An object of type covariateData as generated using <a href="#">getDbCovariateData</a> .
file	The name of the folder where the data will be written. The folder should not yet exist.

**Details**

The data will be written to a set of files in the folder specified by the user.

**Examples**

```
# todo
```

---

savePlpData

*Save the PatientLevelPrediction data to folder*

---

**Description**

savePlpData saves an object of type plpData to folder.

**Usage**

```
savePlpData(plpData, file)
```

**Arguments**

plpData	An object of type plpData as generated using getDbPLPData.
file	The name of the folder where the data will be written. The folder should not yet exist.

**Details**

The data will be written to a set of files in the folder specified by the user.

**Examples**

```
# todo
```

---

simulateplpData

*Generate simulated data*

---

**Description**

simulateplpData creates a plpData object with simulated data.

**Usage**

```
simulateplpData(plpDataSimulationProfile, n = 10000)
```

**Arguments**

plpDataSimulationProfile	An object of type plpDataSimulationProfile as generated using the createplpDataSimulationProfile function.
n	The size of the population to be generated.

**Details**

This function generates simulated data that is in many ways similar to the original data on which the simulation profile is based. The contains same outcome, comparator, and outcome concept IDs, and the covariates and their 1st order statistics should be comparable.

**Value**

An object of type plpData.

---

splitData	<i>Split data into random subsets</i>
-----------	---------------------------------------

---

**Description**

Split data into random subsets

**Usage**

```
splitData(plpData, splits = 2)
```

**Arguments**

plpData	An object of type plpData.
splits	This can be either a single integer, in which case the data will be split up into equally sized parts. If a vector is provided instead, these are interpreted as the relative sizes of each part.

**Details**

Splits cohort, covariate, and outcome data into random subsets, to be used for validation.

**Value**

A list with entries for each part. An entry itself is a plpData object.

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