

# Package ‘SelfControlledCaseSeries’

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**Type** Package

**Title** Self-Controlled Case Series

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**Description** SelfControlledCaseSeries is an R package for performing self-controlled case series (SCCS) analyses in an observational database in the OMOP Common Data Model. It extracts all necessary data from the database and transforms it to the format required for SCCS. Age and season can be modeled using splines assuming constant hazard within calendar months. Event-dependent censoring of the observation period can be corrected for. Many exposures can be included at once (MSCCS), with regularization on all coefficients except for the exposure of interest.

**VignetteBuilder** knitr

**URL** <https://github.com/OHDSI/SelfControlledCaseSeries>

**BugReports** <https://github.com/OHDSI/SelfControlledCaseSeries/issues>

**Depends** R (>= 3.2.2),  
Cyclops (>= 1.2.0),  
DatabaseConnector (>= 2.2.0)

**Imports** SqlRender (>= 1.6.0),  
bit,  
ff,  
ffbase (>= 0.12.1),  
Rcpp (>= 0.11.2),  
ParallelLogger,  
splines,  
ggplot2,  
methods

**Suggests** testthat,  
knitr,  
rmarkdown,  
EmpiricalCalibration

**License** Apache License 2.0

**LinkingTo** Rcpp

**NeedsCompilation** yes

**RoxygenNote** 7.1.0

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---

computeMdr

*Compute the minimum detectable relative risk*

---

### Description

Compute the minimum detectable relative risk

**Usage**

```
computeMdrd(
  sccsEraData,
  exposureCovariateId,
  alpha = 0.05,
  power = 0.8,
  twoSided = TRUE,
  method = "binomial"
)
```

**Arguments**

sccsEraData	An object containing study population observation time, outcomes and covariates as created using the <a href="#">createSccsEraData</a> function. This should include the following dataframes: outcomes, covariates, and covariateRef.
exposureCovariateId	Covariate Id for the health exposure of interest.
alpha	Type I error.
power	1 - beta, where beta is the type II error.
twoSided	Consider a two-sided test?
method	The type of sample size formula that will be used. Allowable values are "proportion", "binomial", "SRL1", "SRL2", or "ageEffects". Currently "ageEffects" is not supported.

**Details**

Compute the minimum detectable relative risk (MDRR) for a given study population, using the observed time at risk and total time in days and number of events. Five sample size formulas are implemented: sampling proportion, binomial proportion, 2 signed root likelihood ratio methods, and likelihood extension for age effects. The expressions by Musonda (2006) are used.

**Value**

A data frame with the MDRR, number of events, time at risk, and total time.

**References**

Musonda P, Farrington CP, Whitaker HJ (2006) Samples sizes for self-controlled case series studies, *Statistics in Medicine*, 15;25(15):2618-31

---

createAgeSettings	<i>Create age settings</i>
-------------------	----------------------------

---

**Description**

Create age settings

**Usage**

```
createAgeSettings(
  includeAge = FALSE,
  ageKnots = 5,
  allowRegularization = FALSE,
  computeConfidenceIntervals = FALSE,
  minAge = NULL,
  maxAge = NULL
)
```

**Arguments**

includeAge	Should age be included in the model?
ageKnots	If a single number is provided this is assumed to indicate the number of knots to use for the spline, and the knots are automatically spaced according to equal percentiles of the data. If more than one number is provided these are assumed to be the exact location of the knots in age-days
allowRegularization	When fitting the model, should the covariates defined here be allowed to be regularized?
computeConfidenceIntervals	Should confidence intervals be computed for the covariates defined here? Setting this to FALSE might save computing time when fitting the model. Will be turned to FALSE automatically when allowRegularization = TRUE.
minAge	Minimum age at which patient time will be included in the analysis. Note that information prior to the min age is still used to determine exposure status after the minimum age (e.g. when a prescription was started just prior to reaching the minimum age). Also, outcomes occurring before the minimum age is reached will be considered as prior outcomes when using first outcomes only. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
maxAge	Maximum age at which patient time will be included in the analysis. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.

**Details**

Create an object specifying whether and how age should be included in the model. Age can be included by splitting patient time into calendar months. During a month, the relative risk attributed to age is assumed to be constant, and the risk from month to month is modeled using a cubic spline.

**Value**

An object of type `ageSettings`.

---

createCovariateSettings

*Create covariate settings*


---

## Description

Create covariate settings

## Usage

```
createCovariateSettings(
  includeCovariateIds = NULL,
  excludeCovariateIds = NULL,
  label = "Covariates",
  stratifyById = TRUE,
  start = 0,
  addExposedDaysToStart = FALSE,
  end = 0,
  addExposedDaysToEnd = FALSE,
  firstOccurrenceOnly = FALSE,
  splitPoints = c(),
  allowRegularization = FALSE
)
```

## Arguments

includeCovariateIds	One or more IDs of variables in the <code>sccsData</code> object that should be used to construct this covariate. If no IDs are specified, all variables will be used.
excludeCovariateIds	One or more IDs of variables in the <code>sccsData</code> object that should not be used to construct this covariate.
label	A label used to identify the covariates created using these settings.
stratifyById	Should a single covariate be created for every ID in the <code>sccsData</code> object, or should a single covariate be constructed? For example, if the IDs identify exposures to different drugs, should a covariate be constructed for every drug, or a single covariate for exposure to any of these drugs. Note that overlap will be considered a single exposure.
start	The start of the risk window in days, relative to the exposure start date.
addExposedDaysToStart	Should the length of exposure be added to the start date?
end	The start of the risk window in days, relative to the exposure start date.
addExposedDaysToEnd	Should the length of exposure be added to the end date?
firstOccurrenceOnly	Should only the first occurrence of the exposure be used?
splitPoints	To split the risk window into several smaller windows, specify the end of each sub-window relative to the start of the main risk window. If <code>addExposedDaysToStart</code> is <code>TRUE</code> , the split points will be considered to be relative to the end of the main risk window instead.

allowRegularization

When fitting the model, should the covariates defined here be allowed to be regularized?

## Details

Create an object specifying how to create a (set of) covariates.

## Value

An object of type covariateSettings.

---

createCreateSccsEraDataArgs

*Create a parameter object for the function createSccsEraData*

---

## Description

Create a parameter object for the function createSccsEraData

## Usage

```
createCreateSccsEraDataArgs(
  naivePeriod = 0,
  firstOutcomeOnly = FALSE,
  covariateSettings,
  ageSettings = createAgeSettings(includeAge = FALSE),
  seasonalitySettings = createSeasonalitySettings(includeSeasonality = FALSE),
  minCasesForAgeSeason = 10000,
  eventDependentObservation = FALSE
)
```

## Arguments

naivePeriod	The number of days at the start of a patient's observation period that should not be included in the risk calculations. Note that the naive period can be used to determine current covariate status right after the naive period, and whether an outcome is the first one.
firstOutcomeOnly	Whether only the first occurrence of an outcome should be considered.
covariateSettings	Either an object of type covariateSettings as created using the createCovariateSettings function, or a list of such objects.
ageSettings	An object of type ageSettings as created using the createAgeSettings function.
seasonalitySettings	An object of type seasonalitySettings as created using the createSeasonalitySettings function.
minCasesForAgeSeason	Minimum number of cases to use to fit age and season splines. If needed (and available), cases that are not exposed will be included. #'
eventDependentObservation	Should the extension proposed by Farrington et al. be used to adjust for event-dependent observation time?

**Details**

Create an object defining the parameter values.

---

`createExposureOutcome` *Create a exposure-outcome combination.*

---

**Description**

Create a exposure-outcome combination.

**Usage**

```
createExposureOutcome(exposureId, outcomeId, ...)
```

**Arguments**

<code>exposureId</code>	A concept ID identifying the target drug in the exposure table. If multiple strategies for picking the exposure will be tested in the analysis, a named list of numbers can be provided instead. In the analysis, the name of the number to be used can be specified using the <code>#</code> <code>exposureType</code> parameter in the <a href="#">createSccsAnalysis</a> function.
<code>outcomeId</code>	A concept ID indentifying the outcome in the outcome table.
<code>...</code>	Custom variables, to be used in the analyses.

**Details**

Create a set of hypotheses of interest, to be used with the [runSccsAnalyses](#) function.

---

`createFitSccsModelArgs`  
*Create a parameter object for the function `fitSccsModel`*

---

**Description**

Create a parameter object for the function `fitSccsModel`

**Usage**

```
createFitSccsModelArgs(
  prior = createPrior("laplace", useCrossValidation = TRUE),
  control = createControl(cvType = "auto", selectorType = "byPid", startingVariance =
    0.1, noiseLevel = "quiet")
)
```

**Arguments**

<code>prior</code>	The prior used to fit the model. See <code>createPrior</code> for details.
<code>control</code>	The control object used to control the cross-validation used to determine the hyperparameters of the prior (if applicable). See <code>createControl</code> for details.

## Details

Create an object defining the parameter values.

---

```
createGetDbScCsDataArgs
```

*Create a parameter object for the function getDbScCsData*

---

## Description

Create a parameter object for the function getDbScCsData

## Usage

```
createGetDbScCsDataArgs(
  useCustomCovariates = FALSE,
  useNestingCohort = FALSE,
  nestingCohortId = NULL,
  deleteCovariatesSmallCount = 100,
  studyStartDate = "",
  studyEndDate = "",
  maxCasesPerOutcome = 0,
  exposureIds = "exposureId",
  customCovariateIds = ""
)
```

## Arguments

useCustomCovariates	Create covariates from a custom table?
useNestingCohort	Should the study be nested in a cohort (e.g. people with a specific indication)? If not, the study will be nested in the general population.
nestingCohortId	A cohort definition ID identifying the records in the nestingCohortTable to use as nesting cohort.
deleteCovariatesSmallCount	The minimum count for a covariate to appear in the data to be kept.
studyStartDate	A calendar date specifying the minimum date where data is used. Date format is 'yyyymmdd'.
studyEndDate	A calendar date specifying the maximum date where data is used. Date format is 'yyyymmdd'.
maxCasesPerOutcome	If there are more than this number of cases for a single outcome cases will be sampled to this size. maxCasesPerOutcome = 0 indicates no maximum size.
exposureIds	A list of identifiers to define the exposures of interest. If exposureTable = DRUG_ERA, exposureIds should be CONCEPT_ID. If exposureTable <> DRUG_ERA, exposureIds is used to select the cohort_concept_id in the cohort-like table. If no exposureIds are provided, all drugs or cohorts in the exposureTable are included as exposures.



customCovariateIds

A list of cohort definition IDS identifying the records in the customCovariateTable to use for building customcovariates.

## Details

Create an object defining the parameter values.

---

createSccsAnalysis	<i>Create a SelfControlledCaseSeries analysis specification</i>
--------------------	---

---

## Description

Create a SelfControlledCaseSeries analysis specification

## Usage

```
createSccsAnalysis(
  analysisId = 1,
  description = "",
  exposureType = NULL,
  outcomeType = NULL,
  getDbSccsDataArgs,
  createSccsEraDataArgs,
  fitSccsModelArgs
)
```

## Arguments

analysisId	An integer that will be used later to refer to this specific set of analysis choices.
description	A short description of the analysis.
exposureType	If more than one exposure is provided for each exposureOutcome, this field should be used to select the specific exposure to use in this analysis.
outcomeType	If more than one outcome is provided for each exposureOutcome, this field should be used to select the specific outcome to use in this analysis.
getDbSccsDataArgs	An object representing the arguments to be used when calling the <a href="#">getDbSccsData</a> function.
createSccsEraDataArgs	An object representing the arguments to be used when calling the <a href="#">createSccsEraData</a> function.
fitSccsModelArgs	An object representing the arguments to be used when calling the <a href="#">fitSccsModel</a> function.

## Details

Create a set of analysis choices, to be used with the [runSccsAnalyses](#) function.

---

createSccsEraData	<i>Create SCCS era data</i>
-------------------	-----------------------------

---

## Description

Create SCCS era data

## Usage

```
createSccsEraData(
  sccsData,
  outcomeId = NULL,
  naivePeriod = 0,
  firstOutcomeOnly = FALSE,
  covariateSettings,
  ageSettings = createAgeSettings(includeAge = FALSE),
  seasonalitySettings = createSeasonalitySettings(includeSeasonality = FALSE),
  minCasesForAgeSeason = 10000,
  eventDependentObservation = FALSE
)
```

## Arguments

sccsData	An object of type sccsData as created using the <a href="#">getDbSccsData</a> function.
outcomeId	The outcome to create the era data for. If not specified it is assumed to be the one outcome for which the data was loaded from the database.
naivePeriod	The number of days at the start of a patient's observation period that should not be included in the risk calculations. Note that the naive period can be used to determine current covariate status right after the naive period, and whether an outcome is the first one.
firstOutcomeOnly	Whether only the first occurrence of an outcome should be considered.
covariateSettings	Either an object of type covariateSettings as created using the <a href="#">createCovariateSettings</a> function, or a list of such objects.
ageSettings	An object of type ageSettings as created using the <a href="#">createAgeSettings</a> function.
seasonalitySettings	An object of type seasonalitySettings as created using the <a href="#">createSeasonalitySettings</a> function.
minCasesForAgeSeason	Minimum number of cases to use to fit age and season splines. IF needed (and available), cases that are not exposed will be included.#'
eventDependentObservation	Should the extension proposed by Farrington et al. be used to adjust for event-dependent observation time?

## Details

This function creates covariates based on the data in the sccsData object, according to the provided settings. It chops patient time into periods during which all covariates remain constant. The output details these periods, their durations, and a sparse representation of the covariate values.

**Value**

An object of type `sccsEraData`.

**References**

Farrington, C. P., Anaya-Izquierdo, A., Whitaker, H. J., Hocine, M.N., Douglas, I., and Smeeth, L. (2011). Self-Controlled case series analysis with event-dependent observation periods. *Journal of the American Statistical Association* 106 (494), 417-426

---

```
createSccsSimulationSettings
```

*Create SCCS simulation settings*

---

**Description**

Create SCCS simulation settings

**Usage**

```
createSccsSimulationSettings(
  meanPatientTime = 4 * 365,
  sdPatientTime = 2 * 365,
  minAge = 18 * 365,
  maxAge = 65 * 365,
  minBaselineRate = 0.001,
  maxBaselineRate = 0.01,
  covariateIds = c(1, 2),
  patientUsages = c(0.2, 0.1),
  usageRate = c(0.01, 0.01),
  meanPrescriptionDurations = c(14, 30),
  sdPrescriptionDurations = c(7, 14),
  simulationRiskWindows = list(createSimulationRiskWindow(relativeRisks = 1),
    createSimulationRiskWindow(relativeRisks = 1.5)),
  includeAgeEffect = TRUE,
  ageKnots = 5,
  includeSeasonality = TRUE,
  seasonKnots = 5,
  outcomeId = 10
)
```

**Arguments**

<code>meanPatientTime</code>	Mean number of observation days per patient.
<code>sdPatientTime</code>	Standard deviation of the observation days per patient.
<code>minAge</code>	The minimum age in days.
<code>maxAge</code>	The maximum age in days.
<code>minBaselineRate</code>	The minimum baseline rate (per day).

maxBaselineRate	The maximum baseline rate (per day).
covariateIds	The IDs for the covariates to be generated.
patientUsages	The fraction of patients that use the drugs.
usageRate	The rate of prescriptions per person that uses the drug.
meanPrescriptionDurations	The mean duration of a prescription, per drug.
sdPrescriptionDurations	The standard deviation of the duration of a prescription, per drug.
simulationRiskWindows	One or a list of objects of type <code>simulationRiskWindow</code> as created using the <a href="#">createSimulationRiskWindow</a> function.
includeAgeEffect	Include an age effect for the outcome?
ageKnots	Number of knots in the age spline.
includeSeasonality	Include seasonality for the outcome?
seasonKnots	Number of knots in the seasonality spline.
outcomeId	The ID to be used for the outcome.

### Details

Create an object of settings for an SCCS simulation.

### Value

An object of type `sccsSimulationSettings`.

---

```
createSeasonalitySettings
```

*Create seasonality settings*

---

### Description

Create seasonality settings

### Usage

```
createSeasonalitySettings(
  includeSeasonality = FALSE,
  seasonKnots = 5,
  allowRegularization = FALSE,
  computeConfidenceIntervals = FALSE
)
```

**Arguments**

- `includeSeasonality` Should seasonality be included in the model?
- `seasonKnots` If a single number is provided this is assumed to indicate the number of knots to use for the spline, and the knots are automatically equally spaced across the year. If more than one number is provided these are assumed to be the exact location of the knots in days relative to the start of the year.
- `allowRegularization` When fitting the model, should the covariates defined here be allowed to be regularized?
- `computeConfidenceIntervals` Should confidence intervals be computed for the covariates defined here? Setting this to FALSE might save computing time when fitting the model. Will be turned to FALSE automatically when `allowRegularization = TRUE`.

**Details**

Create an object specifying whether and how seasonality should be included in the model. Seasonality can be included by splitting patient time into calendar months. During a month, the relative risk attributed to season is assumed to be constant, and the risk from month to month is modeled using a cyclic cubic spline.

**Value**

An object of type `seasonalitySettings`.

---

```
createSimulationRiskWindow
```

*Create a risk window definition for simulation*

---

**Description**

Create a risk window definition for simulation

**Usage**

```
createSimulationRiskWindow(
  start = 0,
  end = 0,
  addExposedDaysToEnd = TRUE,
  splitPoints = c(),
  relativeRisks = c(0)
)
```

**Arguments**

- `start` Start of the risk window relative to exposure start.
- `end` End of risk window relative to exposure start, or if `addExposedDaysToEnd` is TRUE, relative to the end date.

addExposedDaysToEnd	Should the length of exposure be added to the end date? In other words, should the exposure end date be used as reference point for the risk window end?
splitPoints	Subdivision of the risk window in to smaller sub-windows.
relativeRisks	Either a single number representing the relative risk in the risk window, or when splitPoints have been defined a vector of relative risks, one for each sub-window.

**Value**

An object of type `simulationRiskWindow`.

---

<code>cyclicSplineDesign</code>	<i>Create a design matrix for a cyclic spline</i>
---------------------------------	---

---

**Description**

Create a design matrix for a cyclic spline

**Usage**

```
cyclicSplineDesign(x, knots, ord = 4)
```

**Arguments**

<code>x</code>	Vector of coordinates of the points to be interpolated.
<code>knots</code>	Location of the knots.
<code>ord</code>	Order of the spline function.

**Details**

This function is used by other functions in this package.

---

<code>fitSccsModel</code>	<i>Fit the SCCS model</i>
---------------------------	---------------------------

---

**Description**

Fit the SCCS model

**Usage**

```
fitSccsModel(
  sccsEraData,
  prior = createPrior("laplace", useCrossValidation = TRUE),
  control = createControl(cvType = "auto", selectorType = "byPid", startingVariance =
    0.1, noiseLevel = "quiet")
)
```

**Arguments**

sccsEraData	An object of type sccsEraData as created using the <a href="#">createSccsEraData</a> function.
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.

**Details**

Fits the SCCS model as a conditional Poisson regression. When allowed, coefficients for some or all covariates can be regularized.

**Value**

An object of type sccsModel. Generic functions summary, coef, and confint are available.

**References**

Suchard, M.A., Simpson, S.E., Zorych, I., Ryan, P., and Madigan, D. (2013). Massive parallelization of serial inference algorithms for complex generalized linear models. *ACM Transactions on Modeling and Computer Simulation* 23, 10

---

forceSccsEraDataIntoRam

*Force a loaded SCCS era data in RAM*

---

**Description**

forceSccsEraDataIntoRam converts the ffd components of an sccsEraData object into data.table components

**Usage**

```
forceSccsEraDataIntoRam(sccsEraData)
```

**Arguments**

sccsEraData	Existing sccsEraData object.
-------------	------------------------------

**Details**

Uses `ff::as.ram()` to move virtual data into data.table objects

**Value**

An object of class sccsEraData

getDbScCsData

*Load data for SCCS from the database***Description**

Load all data needed to perform an SCCS analysis from the database.

**Usage**

```
getDbScCsData(
  connectionDetails,
  cdmDatabaseSchema,
  oracleTempSchema = cdmDatabaseSchema,
  outcomeDatabaseSchema = cdmDatabaseSchema,
  outcomeTable = "condition_era",
  outcomeIds,
  exposureDatabaseSchema = cdmDatabaseSchema,
  exposureTable = "drug_era",
  exposureIds = c(),
  useCustomCovariates = FALSE,
  customCovariateDatabaseSchema = cdmDatabaseSchema,
  customCovariateTable = "cohort",
  customCovariateIds = c(),
  useNestingCohort = FALSE,
  nestingCohortDatabaseSchema = cdmDatabaseSchema,
  nestingCohortTable = "cohort",
  nestingCohortId = NULL,
  deleteCovariatesSmallCount = 100,
  studyStartDate = "",
  studyEndDate = "",
  cdmVersion = "5",
  maxCasesPerOutcome = 0
)
```

**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.

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 is not CONDITION_OCCURRENCE or CONDITION_ERA, then expectation is outcomeTable has format of COHORT table: COHORT_DEFINITION_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.
exposureDatabaseSchema	The name of the database schema that is the location where the exposure data used to define the exposure cohorts is available. If exposureTable = DRUG_ERA, exposureDatabaseSchema is not used but assumed to be cdmSchema. Requires read permissions to this database.
exposureTable	The tablename that contains the exposure cohorts. If exposureTable <> DRUG_ERA, then expectation is exposureTable has format of COHORT table: cohort_concept_id, SUBJECT_ID, COHORT_START_DATE, COHORT_END_DATE.
exposureIds	A list of identifiers to define the exposures of interest. If exposureTable = DRUG_ERA, exposureIds should be CONCEPT_ID. If exposureTable <> DRUG_ERA, exposureIds is used to select the cohort_concept_id in the cohort-like table. If no exposureIds are provided, all drugs or cohorts in the exposureTable are included as exposures.
useCustomCovariates	Create covariates from a custom table?
customCovariateDatabaseSchema	The name of the database schema that is the location where the custom covariate data is available.
customCovariateTable	Name of the table holding the custom covariates. This table should have the same structure as the cohort table.
customCovariateIds	A list of cohort definition IDS identifying the records in the customCovariateTable to use for building custom covariates.
useNestingCohort	Should the study be nested in a cohort (e.g. people with a specific indication)? If not, the study will be nested in the general population.
nestingCohortDatabaseSchema	The name of the database schema that is the location where the nesting cohort is defined.
nestingCohortTable	Name of the table holding the nesting cohort. This table should have the same structure as the cohort table.
nestingCohortId	A cohort definition ID identifying the records in the nestingCohortTable to use as nesting cohort.
deleteCovariatesSmallCount	The minimum count for a covariate to appear in the data to be kept.
studyStartDate	A calendar date specifying the minimum date where data is used. Date format is 'yyyymmdd'.
studyEndDate	A calendar date specifying the maximum date where data is used. Date format is 'yyyymmdd'.

**cdmVersion** Define the OMOP CDM version used: currently support "4" and "5".

**maxCasesPerOutcome** If there are more than this number of cases for a single outcome cases will be sampled to this size. `maxCasesPerOutcome = 0` indicates no maximum size.

## Details

This function downloads several types of information:

- Information on the occurrences of the outcome(s) of interest. Note that information for multiple outcomes can be fetched in one go, and later the specific outcome can be specified for which we want to build a model.
- Information on the observation time and age for the people with the outcomes.
- Information on exposures of interest which we want to include in the model.

Five different database schemas can be specified, for five different types of information: The `cdmDatabaseSchema` is used to extract patient age and observation period. The `outcomeDatabaseSchema` is used to extract information about the outcomes, the `exposureDatabaseSchema` is used to retrieve information on exposures, and the `customCovariateDatabaseSchema` is optionally used to find additional, user-defined covariates. All four locations could point to the same database schema. `nestingCohortDatabaseSchema` is optionally used to define a cohort in which the analysis is nested, for example a cohort of diabetics patients.

All five locations could point to the same database schema.

## Value

Returns an object of type `sccsData`, containing information on the cases, their outcomes, exposures, and potentially other covariates. Information about multiple outcomes can be captured at once for efficiency reasons. This object is a list with the following components:

**cases** An `ffdf` object listing the persons that have the outcome(s), their age, and observation time.

**eras** An `ffdf` object listing the exposures, outcomes and other covariates.

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

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

The generic `summary()` function has been implemented for this object.

---

<code>getModel</code>	<i>Output the full model</i>
-----------------------	------------------------------

---

## Description

Output the full model

## Usage

```
getModel(sccsModel)
```

## Arguments

**sccsModel** An object of type `sccsModel` as created using the [fitSccsModel](#) function.

**Value**

A data frame with the coefficients and confidence intervals (when not-regularized) for all covariates in the model.

---

`loadExposureOutcomeList`*Load a list of exposureOutcome from file*

---

**Description**

Load a list of objects of type exposureOutcome from file. The file is in JSON format.

**Usage**

```
loadExposureOutcomeList(file)
```

**Arguments**

<code>file</code>	The name of the file
-------------------	----------------------

**Value**

A list of objects of type exposureOutcome.

---

`loadSccsAnalysisList`*Load a list of sccsAnalysis from file*

---

**Description**

Load a list of objects of type sccsAnalysis from file. The file is in JSON format.

**Usage**

```
loadSccsAnalysisList(file)
```

**Arguments**

<code>file</code>	The name of the file
-------------------	----------------------

**Value**

A list of objects of type sccsAnalysis.

---

loadSccsData	<i>Load the SCCS data from a folder</i>
--------------	---

---

**Description**

loadSccsData loads an object of type sccsData from a folder in the file system.

**Usage**

```
loadSccsData(folder, readOnly = TRUE)
```

**Arguments**

folder	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 cohortData.

---

loadSccsEraData	<i>Load the SCCS era data from a folder</i>
-----------------	---

---

**Description**

loadSccsEraData loads an object of type sccsEraData from a folder in the file system.

**Usage**

```
loadSccsEraData(folder, readOnly = FALSE)
```

**Arguments**

folder	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 sccsEraData

---

plotAgeEffect	<i>Plot the age effect</i>
---------------	----------------------------

---

**Description**

Plot the age effect

**Usage**

```
plotAgeEffect(sccsModel, rrLim = c(0.1, 10), fileName = NULL)
```

**Arguments**

sccsModel	An object of type <code>sccsModel</code> as created using the <a href="#">fitSccsModel</a> function.
rrLim	The limits on the incidence rate ratio scale in the plot.
fileName	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**

Plot the spline curve of the age effect.

**Value**

A Ggplot object. Use the `ggsave` function to save to file.

---

plotAgeSpans	<i>Plot the age ranges spanned by each observation period.</i>
--------------	--

---

**Description**

Plot the age ranges spanned by each observation period.

**Usage**

```
plotAgeSpans(  
  sccsData,  
  outcomeId = NULL,  
  firstOutcomeOnly = FALSE,  
  naivePeriod = 0,  
  minAge = NULL,  
  maxAge = NULL,  
  fileName = NULL  
)
```

**Arguments**

sccsData	An object of type sccsData as created using the <a href="#">getDbSccsData</a> function.
outcomeId	The outcome to create the era data for. If not specified it is assumed to be the one outcome for which the data was loaded from the database.
firstOutcomeOnly	Whether only the first occurrence of an outcome should be considered.
naivePeriod	The number of days at the start of a patient's observation period that should not be included in the risk calculations. Note that the naive period can be used to determine current covariate status right after the naive period, and whether an outcome is the first one.
minAge	Minimum age at which patient time will be included in the analysis. Note that information prior to the min age is still used to determine exposure status after the minimum age (e.g. when a prescription was started just prior to reaching the minimum age). Also, outcomes occurring before the minimum age is reached will be considered as prior outcomes when using first outcomes only. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
maxAge	Maximum age at which patient time will be included in the analysis. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
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**

If parameters such as naivePeriod, minAge, and maxAge are provided, these will first be applied to curtail the observation period prior to plotting. Similarly, firstOutcomeOnly can be provided so subjects where the first outcome falls before the true observation start are removed before plotting.

**Value**

A Ggplot object. Use the ggsave function to save to file.

---

plotEventObservationDependence

*Plot time from event to observation end for censored and uncensored time.*

---

**Description**

Plot time from event to observation end for censored and uncensored time.

**Usage**

```
plotEventObservationDependence(
  sccsData,
  outcomeId = NULL,
  naivePeriod = 0,
  minAge = NULL,
  maxAge = NULL,
  fileName = NULL
)
```

**Arguments**

sccsData	An object of type <code>sccsData</code> as created using the <code>getDbSccsData</code> function.
outcomeId	The outcome to create the era data for. If not specified it is assumed to be the one outcome for which the data was loaded from the database.
naivePeriod	The number of days at the start of a patient's observation period that should not be included in the risk calculations. Note that the naive period can be used to determine current covariate status right after the naive period, and whether an outcome is the first one.
minAge	Minimum age at which patient time will be included in the analysis. Note that information prior to the min age is still used to determine exposure status after the minimum age (e.g. when a prescription was started just prior to reaching the minimum age). Also, outcomes occurring before the minimum age is reached will be considered as prior outcomes when using first outcomes only. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
maxAge	Maximum age at which patient time will be included in the analysis. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
fileName	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**

This plot shows whether there is a difference in time between (first) event and the observation period end for periods that are 'censored' and those that are 'uncensored'. By 'censored' we mean periods that end before we would normally expect. Here, we define periods to be uncensored if they end at either the study end date (if specified), database end date (i.e. the date after which no data is captured in the database), or maximum age (if specified). All other periods are assumed to be censored.

As proposed by Farrington et al., by comparing the two plots, we can gain some insight into whether the censoring is dependent on the occurrence of the event.

If parameters such as `naivePeriod`, `minAge`, and `maxAge` are provided, these will first be applied to curtail the observation period prior to plotting. Similarly, `firstOutcomeOnly` can be provided so subjects where the first outcome falls before the true observation start are removed before plotting.

**Value**

A Ggplot object. Use the `ggsave` function to save to file.

**References**

Farrington P, Whitaker H, Ghebremichael Weldeselassie Y (2018), Self-controlled case series studies: A modelling guide with R, Taylor & Francis

---

plotEventToCalendarTime

*Plot the count of events over calendar time.*


---

## Description

Plot the count of events over calendar time.

## Usage

```
plotEventToCalendarTime(
  sccsData,
  outcomeId = NULL,
  naivePeriod = 0,
  minAge = NULL,
  maxAge = NULL,
  fileName = NULL
)
```

## Arguments

sccsData	An object of type sccsData as created using the <a href="#">getDbSccsData</a> function.
outcomeId	The outcome to create the era data for. If not specified it is assumed to be the one outcome for which the data was loaded from the database.
naivePeriod	The number of days at the start of a patient's observation period that should not be included in the risk calculations. Note that the naive period can be used to determine current covariate status right after the naive period, and whether an outcome is the first one.
minAge	Minimum age at which patient time will be included in the analysis. Note that information prior to the min age is still used to determine exposure status after the minimum age (e.g. when a prescription was started just prior to reaching the minimum age). Also, outcomes occurring before the minimum age is reached will be considered as prior outcomes when using first outcomes only. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
maxAge	Maximum age at which patient time will be included in the analysis. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
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.

## Value

A Ggplot object. Use the ggsave function to save to file.



---

plotExposureCentered    *Plot information centered around the start of exposure*

---

## Description

Plot information centered around the start of exposure

## Usage

```
plotExposureCentered(
  sccsData,
  outcomeId = NULL,
  exposureId = NULL,
  naivePeriod = 0,
  firstOutcomeOnly = FALSE,
  minAge = NULL,
  maxAge = NULL,
  fileName = NULL
)
```

## Arguments

sccsData	An object of type sccsData as created using the <a href="#">getDbSccsData</a> function.
outcomeId	The outcome to create the era data for. If not specified it is assumed to be the one outcome for which the data was loaded from the database.
exposureId	The exposure to create the era data for. If not specified it is assumed to be the one exposure for which the data was loaded from the database.
naivePeriod	The number of days at the start of a patient's observation period that should not be included in the risk calculations. Note that the naive period can be used to determine current covariate status right after the naive period, and whether an outcome is the first one.
firstOutcomeOnly	Whether only the first occurrence of an outcome should be considered.
minAge	Minimum age at which patient time will be included in the analysis. Note that information prior to the min age is still used to determine exposure status after the minimum age (e.g. when a prescription was started just prior to reaching the minimum age). Also, outcomes occurring before the minimum age is reached will be considered as prior outcomes when using first outcomes only. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
maxAge	Maximum age at which patient time will be included in the analysis. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
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

This plot shows the number of events and the number of subjects under observation in week-sized intervals relative to the start of the first exposure.

If parameters such as `naivePeriod`, `minAge`, and `maxAge` are provided, these will first be applied to curtail the observation period prior to plotting. Similarly, `firstOutcomeOnly` can be provided so subjects where the first outcome falls before the true observation start are removed before plotting.

## Value

A Ggplot object. Use the `ggsave` function to save to file.

---

<code>plotPerPersonData</code>	<i>Plot exposures and outcomes per person</i>
--------------------------------	---

---

## Description

Plot exposures and outcomes per person

## Usage

```
plotPerPersonData(
  sccsData,
  outcomeId = NULL,
  exposureId = NULL,
  naivePeriod = 0,
  firstOutcomeOnly = FALSE,
  minAge = NULL,
  maxAge = NULL,
  fileName = NULL
)
```

## Arguments

<code>sccsData</code>	An object of type <code>sccsData</code> as created using the <a href="#">getDbSccsData</a> function.
<code>outcomeId</code>	The outcome to create the era data for. If not specified it is assumed to be the one outcome for which the data was loaded from the database.
<code>exposureId</code>	The exposure to create the era data for. If not specified it is assumed to be the one exposure for which the data was loaded from the database.
<code>naivePeriod</code>	The number of days at the start of a patient's observation period that should not be included in the risk calculations. Note that the naive period can be used to determine current covariate status right after the naive period, and whether an outcome is the first one.
<code>firstOutcomeOnly</code>	Whether only the first occurrence of an outcome should be considered.
<code>minAge</code>	Minimum age at which patient time will be included in the analysis. Note that information prior to the min age is still used to determine exposure status after the minimum age (e.g. when a prescription was started just prior to reaching the minimum age). Also, outcomes occurring before the minimum age is reached will be considered as prior outcomes when using first outcomes only. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.

maxAge	Maximum age at which patient time will be included in the analysis. Age should be specified in years, but non-integer values are allowed. If not specified, no age restriction will be applied.
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

This plot shows the observation time (black), exposures (red), and outcomes (yellow) per person.

If parameters such as naivePeriod, minAge, and maxAge are provided, these will first be applied to curtail the observation period prior to plotting. Similarly, firstOutcomeOnly can be provided so subjects where the first outcome falls before the true observation start are removed before plotting.

### Value

A Ggplot object. Use the ggsave function to save to file.

---

plotSeasonality	<i>Plot the seasonality effect</i>
-----------------	------------------------------------

---

### Description

Plot the seasonality effect

### Usage

```
plotSeasonality(sccsModel, rrLim = c(0.1, 10), fileName = NULL)
```

### Arguments

sccsModel	An object of type sccsModel as created using the <a href="#">fitSccsModel</a> function.
rrLim	The limits on the incidence rate ratio scale in the plot.
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

Plot the spline curve of the seasonality effect.

### Value

A Ggplot object. Use the ggsave function to save to file.

---

runSccsAnalyses	<i>Run a list of analyses</i>
-----------------	-------------------------------

---

## Description

Run a list of analyses

## Usage

```
runSccsAnalyses(
  connectionDetails,
  cdmDatabaseSchema,
  oracleTempSchema = cdmDatabaseSchema,
  exposureDatabaseSchema = cdmDatabaseSchema,
  exposureTable = "drug_era",
  outcomeDatabaseSchema = cdmDatabaseSchema,
  outcomeTable = "condition_era",
  customCovariateDatabaseSchema = cdmDatabaseSchema,
  customCovariateTable = "cohort",
  nestingCohortDatabaseSchema = cdmDatabaseSchema,
  nestingCohortTable = "cohort",
  cdmVersion = 5,
  outputFolder = "./SccsOutput",
  sccsAnalysisList,
  exposureOutcomeList,
  combineDataFetchAcrossOutcomes = TRUE,
  compressSccsEraDataFiles = FALSE,
  getDbSccsDataThreads = 1,
  createSccsEraDataThreads = 1,
  fitSccsModelThreads = 1,
  cvThreads = 1
)
```

## 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.

exposureDatabaseSchema

The name of the database schema that is the location where the exposure data used to define the exposure cohorts is available. If `exposureTable = DRUG_ERA`, `exposureDatabaseSchema` is not used but assumed to be `cdmSchema`. Requires read permissions to this database.

exposureTable	The tablename that contains the exposure cohorts. If exposureTable $\neq$ DRUG_ERA, then expectation is exposureTable has format of COHORT table: cohort_concept_id, SUBJECT_ID, COHORT_START_DATE, COHORT_END_DATE.
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 is not CONDITION_OCCURRENCE or CONDITION_ERA, then expectation is outcomeTable has format of COHORT table: COHORT_DEFINITION_ID, SUBJECT_ID, COHORT_START_DATE, COHORT_END_DATE.
customCovariateDatabaseSchema	The name of the database schema that is the location where the custom covariate data is available.
customCovariateTable	Name of the table holding the custom covariates. This table should have the same structure as the cohort table.
nestingCohortDatabaseSchema	The name of the database schema that is the location where the nesting cohort is defined.
nestingCohortTable	Name of the table holding the nesting cohort. This table should have the same structure as the cohort table.
cdmVersion	Define the OMOP CDM version used: currently support "4" and "5".
outputFolder	Name of the folder where all the outputs will written to.
sccsAnalysisList	A list of objects of type sccsAnalysis as created using the <a href="#">createSccsAnalysis</a> function.
exposureOutcomeList	A list of objects of type exposureOutcome as created using the <a href="#">createExposureOutcome</a> function.
combineDataFetchAcrossOutcomes	Should fetching data from the database be done one outcome at a time, or for all outcomes in one fetch? Combining fetches will be more efficient if there is large overlap in the subjects that have the different outcomes.
compressSccsEraDataFiles	Should compression be used when saving?
getDbSccsDataThreads	The number of parallel threads to use for building the sccsData objects.
createSccsEraDataThreads	The number of parallel threads to use for building the sccsEraData objects.
fitSccsModelThreads	The number of parallel threads to use for fitting the models.
cvThreads	The number of parallel threads to use for the cross- validation when estimating the hyperparameter for the outcome model. Note that the total number of CV threads at one time could be 'fitSccsModelThreads * cvThreads'.

**Details**

Run a list of analyses for the drug-comparator-outcomes of interest. This function will run all specified analyses against all hypotheses of interest, meaning that the total number of outcome models is `'length(cmAnalysisList) * length(drugComparatorOutcomesList)'` (if all analyses specify an outcome model should be fitted). When you provide several analyses it will determine whether any of the analyses have anything in common, and will take advantage of this fact. For example, if we specify several analyses that only differ in the way the outcome model is fitted, then this function will extract the data and fit the propensity model only once, and re-use this in all the analysis.

**Value**

A data frame with the following columns:

<code>analysisId</code>	The unique identifier for a set of analysis choices.
<code>exposureId</code>	The ID of the target drug.
<code>outcomeId</code>	The ID of the outcome.
<code>sccsDataFolder</code>	The folder where the <code>sccsData</code> object is stored.
<code>sccsEraDataFolder</code>	The folder where the <code>sccsEraData</code> object is stored.
<code>sccsModelFile</code>	The file where the fitted SCCS model is stored.

---

`saveExposureOutcomeList`

*Save a list of exposureOutcome to file*

---

**Description**

Write a list of objects of type `exposureOutcome` to file. The file is in JSON format.

**Usage**

```
saveExposureOutcomeList(exposureOutcomeList, file)
```

**Arguments**

<code>exposureOutcomeList</code>	The <code>exposureOutcome</code> list to be written to file
<code>file</code>	The name of the file where the results will be written

---

`saveSccsAnalysisList`    *Save a list of sccsAnalysis to file*

---

**Description**

Write a list of objects of type `sccsAnalysis` to file. The file is in JSON format.

**Usage**

```
saveSccsAnalysisList(sccsAnalysisList, file)
```

**Arguments**

sccsAnalysisList	The sccsAnalysis list to be written to file
file	The name of the file where the results will be written

---

saveSccsData	<i>Save the SCCS data to folder</i>
--------------	-------------------------------------

---

**Description**

sccsData saves an object of type sccsData to folder.

**Usage**

```
saveSccsData(sccsData, folder)
```

**Arguments**

sccsData	An object of type sccsData as generated using <a href="#">getDbSccsData</a> .
folder	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 specified folder.

**Examples**

```
# todo
```

---

saveSccsEraData	<i>Save the SCCS era data to folder</i>
-----------------	---

---

**Description**

saveSccsEraData saves an object of type sccsEraData to folder.

**Usage**

```
saveSccsEraData(sccsEraData, folder, compress = FALSE)
```

**Arguments**

sccsEraData	An object of type sccsEraData as generated using <a href="#">createSccsEraData</a> .
folder	The name of the folder where the data will be written. The folder should not yet exist.
compress	Should compression be used when saving?

**Details**

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

---

simulateSccsData	<i>Simulate SCCS data</i>
------------------	---------------------------

---

**Description**

Simulate SCCS data

**Usage**

```
simulateSccsData(nCases, settings)
```

**Arguments**

nCases	The number of cases to simulate.
settings	An object of type <code>sccsSimulationSettings</code> as created using the <a href="#">createSccsSimulationSettings</a>

**Value**

An object of type `sccsData`.

---

summarizeSccsAnalyses	<i>Create a summary report of the analyses</i>
-----------------------	--

---

**Description**

Create a summary report of the analyses

**Usage**

```
summarizeSccsAnalyses(outcomeReference, outputFolder)
```

**Arguments**

outcomeReference	A data.frame as created by the <a href="#">runSccsAnalyses</a> function.
outputFolder	Name of the folder where all the outputs have been written to.

**Value**

A data frame with the following columns:

analysisId	The unique identifier for a set of analysis choices.
targetId	The ID of the target drug.
comparatorId	The ID of the comparator group.
indicationConceptIds	The ID(s) of indications in which to nest to study.
outcomeId	The ID of the outcome.
rr	The estimated effect size.
ci95lb	The lower bound of the 95 percent confidence interval.
ci95ub	The upper bound of the 95 percent confidence interval.
treated	The number of subjects in the treated group (after any trimming and matching).



comparator	The number of subjects in the comparator group (after any trimming and matching).
eventsTreated	The number of outcomes in the treated group (after any trimming and matching).
eventsComparator	The number of outcomes in the comparator group (after any trimming and matching).
logRr	The log of the estimated relative risk.
seLogRr	The standard error of the log of the estimated relative risk.

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