

Package ‘ruin’

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Type Package

Title Simulation of Various Risk Processes

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Description A (not yet exhaustive) collection of common models of risk processes in actuarial science, represented as formal S4 classes. Each class (risk model) has a simulator of its path, and a plotting function. Further, a Monte-Carlo estimator of a ruin probability for a finite time is implemented, using a parallel computation. Currently, the package extends two classical risk models Cramer-Lundberg and Sparre Andersen models by including capital injections, that are positive jumps (see Breuer L. and Badescu A.L. (2014) <doi:10.1080/03461238.2011.636969>). The intent of the package is to provide a user-friendly interface for ruin processes' simulators, as well as a solid and extensible structure for future extensions.

License GPL-3

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BugReports <http://github.com/irudnyts/ruin/issues>

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CramerLundberg	<i>Constructs an object of CramerLundberg S4 class</i>
----------------	--

Description

CramerLundberg() constructs an object of CramerLundberg S4 class.

Usage

```
CramerLundberg(initial_capital = NULL, premium_rate = NULL,
  claim_poisson_arrival_rate = NULL, claim_size_generator = NULL,
  claim_size_parameters = NULL)
```

Arguments

- `initial_capital` a length one numeric non-negative vector specifying an initial capital. Default: 0.
- `premium_rate` a length one numeric non-negative vector specifying a premium rate. Default: 1.
- `claim_poisson_arrival_rate` a length one numeric positive vector specifying the rate of the Poisson process of claims' arrivals. Default: 1.
- `claim_size_generator` a function indicating the random generator of claims' sizes. Default: `rexp`.
- `claim_size_parameters` a named list containing parameters for the random generator of claims' sizes. Default: `list(rate = 1)`.

Details

The function constructs an object of a formal S4 class `CramerLundberg`, a representation of classical risk process defined as follows:

$$X(t) = u + ct - \sum_{i=1}^{N(t)} Y_i,$$

where u is the initial capital (`initial_capital`), c is the premium rate (`premium_rate`), $N(t)$ is the Poisson process with intensity λ (`claim_poisson_arrival_rate`), Y_i are iid claim sizes (`claim_size_generator` and `claim_size_parameters`).

Value

An object of `CramerLundberg` class.

References

Albrecher H., Asmussen A. *Ruin Probabilities*. World Scientific, 2010.

See Also

[CramerLundbergCapitalInjections](#), [SparreAndersen](#), `link{SparreAndersenCapitalInjections}`.

Examples

```
model <- CramerLundberg(initial_capital = 10,
  premium_rate = 1,
  claim_poisson_arrival_rate = 1,
  claim_size_generator = rexp,
  claim_size_parameters = list(rate = 1))
```

CramerLundberg-class *A formal S4 class CramerLundberg*

Description

A formal S4 class representation of classical Cramer-Lundberg model.

Details

The model is defined as follows:

$$X(t) = u + ct - \sum_{i=1}^{N(t)} Y_i,$$

where u is the initial capital (`initial_capital`), c is the premium rate (`premium_rate`), $N(t)$ is the Poisson process with intensity λ (`claim_poisson_arrival_rate`), Y_i are iid claim sizes (`claim_size_generator` and `claim_size_parameters`).

Objects of class can be created only by using the constructor [CramerLundberg](#).

Slots

`initial_capital` a length one numeric non-negative vector specifying an initial capital.

`premium_rate` a length one numeric non-negative vector specifying a premium rate.

`claim_poisson_arrival_rate` a length one numeric positive vector specifying the rate of the Poisson process of claims' arrivals.

`claim_size_generator` a function indicating the random generator of claims' sizes.

`claim_size_parameters` a named list containing parameters for the random generator of claims' sizes.

References

Albrecher H., Asmussen A. *Ruin Probabilities*. World Scientific, 2010.

See Also

[CramerLundberg](#)

CramerLundbergCapitalInjections

Constructs an object of CramerLundbergCapitalInjections S4 class

Description

CramerLundbergCapitalInjections() constructs an object of CramerLundbergCapitalInjections S4 class.

Usage

```
CramerLundbergCapitalInjections(initial_capital = NULL, premium_rate = NULL,  
  claim_poisson_arrival_rate = NULL, claim_size_generator = NULL,  
  claim_size_parameters = NULL, capital_injection_poisson_rate = NULL,  
  capital_injection_size_generator = NULL,  
  capital_injection_size_parameters = NULL)
```

Arguments

`initial_capital` a length one numeric non-negative vector specifying an initial capital. Default: 0.

`premium_rate` a length one numeric non-negative vector specifying a premium rate. Default: 1.

`claim_poisson_arrival_rate` a length one numeric positive vector specifying the rate of the Poisson process of claims' arrivals. Default: 1.

`claim_size_generator` a function indicating the random generator of claims' sizes. Default: `rexp`.

`claim_size_parameters` a named list containing parameters for the random generator of claims' sizes. Default: `list(rate = 1)`.

`capital_injection_poisson_rate` a length one numeric positive vector specifying the rate of the Poisson process of capital injections' arrivals. Default: 1.

`capital_injection_size_generator` a function indicating the random generator of capital injections' sizes. Default: `rexp`.

`capital_injection_size_parameters` a named list containing parameters for the random generator of capital injections' sizes. Default: `list(rate = 1)`.

Details

The function constructs an object of a formal S4 class `CramerLundbergCapitalInjections`, a representation of an extension of Cramer-Lundberg model that allows for positive jumps and defined as follows:

$$X(t) = u + ct + \sum_{k=1}^{N^{(+)}(t)} Y_k^{(+)} - \sum_{i=1}^{N^{(-)}(t)} Y_i^{(-)}$$

where u is the initial capital (`initial_capital`), c is the premium rate (`premium_rate`), $N^{(+)}(t)$ is the Poisson process of positive jumps (capital injections) with intensity $\lambda^{(+)}$ (`capital_injection_poisson_rate`), $Y_k^{(+)}$ are iid capital injections' sizes (`capital_injection_size_generator` and `capital_injection_size_parameters`), $N^{(-)}(t)$ is the Poisson process of negative jumps (claims) with intensity $\lambda^{(-)}$ (`claim_poisson_arrival_rate`), $Y_i^{(-)}$ are iid claim sizes (`claim_size_generator` and `claim_size_parameters`).

Value

An object of `CramerLundbergCapitalInjections` class.

References

Breuera L., Badescu A. L. *A generalised Gerber Shiu measure for Markov-additive risk processes with phase-type claims and capital injections*. Scandinavian Actuarial Journal, 2014(2): 93-115, 2014.

See Also

`CramerLundberg`, `SparreAndersen`, `link{SparreAndersenCapitalInjections}`.

Examples

```
model <- CramerLundbergCapitalInjections(
  initial_capital = 10,
  premium_rate = 1,
  claim_poisson_arrival_rate = 1,
  claim_size_generator = rexp,
  claim_size_parameters = list(rate = 1),
  capital_injection_poisson_rate = 1,
  capital_injection_size_generator = rexp,
  capital_injection_size_parameters = list(rate = 1)
)
```

CramerLundbergCapitalInjections-class

A formal S4 class CramerLundbergCapitalInjections

Description

A formal S4 class representation of Cramer-Lundberg's extension that includes capital injections.

Details

The model is defined as follows:

$$X(t) = u + ct + \sum_{k=1}^{N^{(+)}(t)} Y_k^{(+)} - \sum_{i=1}^{N^{(-)}(t)} Y_i^{(-)}$$

where u is the initial capital (`initial_capital`), c is the premium rate (`premium_rate`), $N^{(+)}(t)$ is the Poisson process of positive jumps (capital injections) with intensity $\lambda^{(+)}$ (`capital_injection_poisson_rate`), $Y_k^{(+)}$ are iid capital injections' sizes (`capital_injection_size_generator` and `capital_injection_size_parameters`), $N^{(-)}(t)$ is the Poisson process of negative jumps (claims) with intensity $\lambda^{(-)}$ (`claim_poisson_arrival_rate`), $Y_i^{(-)}$ are iid claim sizes (`claim_size_generator` and `claim_size_parameters`).

Objects of class can be created only by using the constructor [CramerLundbergCapitalInjections](#).

Slots

`initial_capital` a length one numeric non-negative vector specifying an initial capital.

`premium_rate` a length one numeric non-negative vector specifying a premium rate.

`claim_poisson_arrival_rate` a length one numeric positive vector specifying the rate of the Poisson process of claims' arrivals.

`claim_size_generator` a function indicating the random generator of claims' sizes.

`claim_size_parameters` a named list containing parameters for the random generator of claims' sizes.

`capital_injection_poisson_rate` a length one numeric positive vector specifying the rate of the Poisson process of capital injections' arrivals.

`capital_injection_size_generator` a function indicating the random generator of capital injections' sizes.

`capital_injection_size_parameters` a named list containing parameters for the random generator of capital injections' sizes.

References

Breuera L., Badescu A. L. *A generalised Gerber Shiu measure for Markov-additive risk processes with phase-type claims and capital injections*. Scandinavian Actuarial Journal, 2014(2): 93-115, 2014.

See Also

[CramerLundbergCapitalInjections](#)

 PathCramerLundberg-class

A formal S4 class PathCramerLundberg

Description

A formal S4 class to contain a simulated path of [CramerLundberg](#) model.

Details

Objects of the class must not be created manually. Instead, objects of this class are returned by [simulate_path](#).

Slots

`model` an object of [CramerLundberg](#) class.

`path` a numeric matrix of columns "time" and "X" defining the simulated path represented by pairs time-value.

`claim_sizes` a numeric vector of claims' sizes.

`claim_arrival_times` a numeric vector of claims' interarrival times.

`time_horizon` a numeric vector of the maximum time horizon achieved.

`is_ruined` a logical vector indicating whether the process is ruined.

`elapsed_time` a numeric vector of the elapsed simulation time in seconds.

`max_time_horizon` a numeric vector of the maximum time horizon allowed.

`max_simulation_time` a numeric vector of the maximum simulation time in seconds.

`seed` a numeric vector indicating the seed used for simulation.

See Also

[CramerLundberg](#) (class definition), [CramerLundberg](#) (constructor).

 PathCramerLundbergCapitalInjections-class

A formal S4 class PathCramerLundbergCapitalInjections

Description

A formal S4 class to contain a simulated path of [CramerLundbergCapitalInjections](#) model.

Details

Objects of the class must not be created manually. Instead, objects of this class are returned by [simulate_path](#).

Slots

`model` an object of [CramerLundbergCapitalInjections](#) class.

`path` a numeric matrix of columns "time" and "X" defining the simulated path represented by pairs time-value.

`claim_sizes` a numeric vector of claims' sizes.

`claim_arrival_times` a numeric vector of claims' interarrival times.

`capital_injection_sizes` a numeric vector of capital injections' sizes.

`capital_injection_arrival_times` a numeric vector of capital injections' interarrival times.

`time_horizon` a numeric vector of the maximum time horizon achieved.

`is_ruined` a logical vector indicating whether the process is ruined.

`elapsed_time` a numeric vector of the elapsed simulation time in seconds.

`max_time_horizon` a numeric vector of the maximum time horizon allowed.

`max_simulation_time` a numeric vector of the maximum simulation time in seconds.

`seed` a numeric vector indicating the seed used for simulation.

See Also

[CramerLundbergCapitalInjections](#) (class definition), [CramerLundbergCapitalInjections](#) (constructor).

PathSparreAndersen-class

A formal S4 class PathSparreAndersen

Description

A formal S4 class to contain a simulated path of [SparreAndersen](#) model.

Details

Objects of the class must not be created manually. Instead, objects of this class are returned by [simulate_path](#).

Slots

`model` an object of [CramerLundberg](#) class.

`path` a numeric matrix of columns "time" and "X" defining the simulated path represented by pairs time-value.

`claim_sizes` a numeric vector of claims' sizes.

`claim_arrival_times` a numeric vector of claims' interarrival times.

`time_horizon` a numeric vector of the maximum time horizon achieved.

`is_ruined` a logical vector indicating whether the process is ruined.

elapsed_time a numeric vector of the elapsed simulation time in seconds.
 max_time_horizon a numeric vector of the maximum time horizon allowed.
 max_simulation_time a numeric vector of the maximum simulation time in seconds.
 seed a numeric vector indicating the seed used for simulation.

See Also

[SparreAndersen](#) (class definition), [SparreAndersen](#) (constructor).

PathSparreAndersenCapitalInjections-class

A formal S4 class PathSparreAndersenCapitalInjections

Description

A formal S4 class to contain a simulated path of [SparreAndersenCapitalInjections](#) model.

Details

Objects of the class must not be created manually. Instead, objects of this class are returned by [simulate_path](#).

Slots

model an object of [SparreAndersenCapitalInjections](#) class.
 path a numeric matrix of columns "time" and "X" defining the simulated path represented by pairs time-value.
 claim_sizes a numeric vector of claims' sizes.
 claim_arrival_times a numeric vector of claims' interarrival times.
 capital_injection_sizes a numeric vector of capital injections' sizes.
 capital_injection_arrival_times a numeric vector of capital injections' interarrival times.
 time_horizon a numeric vector of the maximum time horizon achieved.
 is_ruined a logical vector indicating whether the process is ruined.
 elapsed_time a numeric vector of the elapsed simulation time in seconds.
 max_time_horizon a numeric vector of the maximum time horizon allowed.
 max_simulation_time a numeric vector of the maximum simulation time in seconds.
 seed a numeric vector indicating the seed used for simulation.

See Also

[SparreAndersenCapitalInjections](#) (class definition), [SparreAndersenCapitalInjections](#) (constructor).

plot_path	<i>Plot a path of the simulated ruin process</i>
-----------	--

Description

plot_path() takes a simulated ruin process as the argument and plots its path.

Usage

```
plot_path(path_object)
```

Arguments

path_object an S4 object of *Path class (e.g., [PathCramerLundberg](#)).

Details

Under the hood, the function uses [ggplot2](#) package, therefore, all functionality from [ggplot2](#) is available.

Value

A [ggplot2](#) object.

Examples

```
model <- CramerLundberg(initial_capital = 10,
                        premium_rate = 1,
                        claim_poisson_arrival_rate = 1,
                        claim_size_generator = rexp,
                        claim_size_parameters = list(rate = 1))

path <- simulate_path(model = model, max_time_horizon = 10)

plot_path(path)
```

ruin_probability	<i>Estimate a ruin probability for a finite time horizon</i>
------------------	--

Description

ruin_probability simulates paths for a given risk model and returns a crude Monte-Carlo estimate of the ruin probability for the finite time horizon.

Usage

```
ruin_probability(model, time_horizon, simulation_number = NULL,
  ci_level = NULL, parallel = NULL, return_paths = NULL)
```

Arguments

<code>model</code>	an S4 object indicating a risk model (e.g., CramerLundberg).
<code>time_horizon</code>	a length one numeric finite vector specifying the time at which the ruin probability should be estimated.
<code>simulation_number</code>	a length one numeric vector giving the number of simulations that should be performed. Default: 10000.
<code>ci_level</code>	a length one numeric vector between 0 and 1 indicating the level of the confidence interval of the ruin probability. Default: 0.95.
<code>parallel</code>	a length one logical vector indicating whether the parallel computing should be used. Default: TRUE.
<code>return_paths</code>	a length one logical vector indicating whether a list of simulated paths should be returned. Default: FALSE.

Details

The function uses a parallel computing from the package [parallel](#) (if `parallel` is TRUE). The package sets up `RNGkind` to "L'Ecuyer-CMRG" for a safe seeding (see [nextRNGStream](#)) when it is loaded, so that user does not have to take care of seeds / RNGs. Further, the function allows computing the confidence interval, assuming the normal distribution of the ruin probability (thanks to CLT).

Value

A list of two elements: a numeric vector of lower bound of CI, estimate, and upper bound of CI of the ruin probability; and optionally the list of simulated paths.

Examples

```
model <- CramerLundberg(initial_capital = 0,
  premium_rate = 1,
  claim_poisson_arrival_rate = 1,
  claim_size_generator = rexp,
  claim_size_parameters = list(rate = 1))
ruin_probability(model = model,
  time_horizon = 10,
  simulation_number = 100,
  return_paths = TRUE,
  parallel = FALSE)
```

simulate_path	<i>Generic for simulating a path of a given risk model</i>
---------------	--

Description

simulate_path() simulates a path of a given risk model until one of the following conditions is met: (1) the process is ruined, (2) max_time_horizon is achieved, (3) the elapsed time of the simulation is greater than max_simulation_time.

Usage

```
simulate_path(model, max_time_horizon = NULL, max_simulation_time = NULL,
             seed = NULL)
```

Arguments

model an S4 object indicating a risk model (e.g., [CramerLundberg](#)).

max_time_horizon a length one numeric vector specifying the maximum time horizon, until with the process will be simulated. Default: Inf.

max_simulation_time a length one numeric vector indicating the maximum allowed time of simulation. The value should be specified in seconds. Default: Inf.

seed an optional arbitrary length numeric vector specifying the seed. If provided, the .Random.seed in .GlobalEnv is set to its value.

Value

An S4 corresponding to model class object. For instance, for [CramerLundberg](#), the object of class [PathCramerLundberg](#) is returned.

Warning

Setting both max_time_horizon and max_simulation_time to Inf might be dangerous. In this case, the only stopping condition is a ruin of the process, which might not happen.

Examples

```
model <- CramerLundberg(initial_capital = 10,
                       premium_rate = 1,
                       claim_poisson_arrival_rate = 1,
                       claim_size_generator = rexp,
                       claim_size_parameters = list(rate = 1))

path <- simulate_path(model = model, max_time_horizon = 10)
```

simulate_path,CramerLundberg-method

Simulates a path of a Cramer-Lundberg model

Description

simulate_path() simulates a path of [CramerLundberg](#) model until one of the following conditions is met: (1) the process is ruined, (2) max_time_horizon is achieved, (3) the elapsed time of the simulation is greater than max_simulation_time.

Usage

```
## S4 method for signature 'CramerLundberg'
simulate_path(model, max_time_horizon = NULL,
              max_simulation_time = NULL, seed = NULL)
```

Arguments

model	an S4 object of CramerLundberg class.
max_time_horizon	a length one numeric vector specifying the maximum time horizon, until with the process will be simulated. Default: Inf.
max_simulation_time	a length one numeric vector indicating the maximum allowed time of simulation. The value should be specified in seconds. Default: Inf.
seed	an optional arbitrary length numeric vector specifying the seed. If provided, the .Random.seed in .GlobalEnv is set to its value.

Value

[PathCramerLundberg](#)

Warning

Setting both max_time_horizon and max_simulation_time to Inf might be dangerous. In this case, the only stopping condition is a ruin of the process, which might not happen.

Examples

```
model <- CramerLundberg(initial_capital = 10,
                       premium_rate = 1,
                       claim_poisson_arrival_rate = 1,
                       claim_size_generator = rexp,
                       claim_size_parameters = list(rate = 1))

path <- simulate_path(model = model, max_time_horizon = 10)
```

simulate_path,CramerLundbergCapitalInjections-method

Simulates a path of a Cramer-Lundberg model's extension with capital injections

Description

simulate_path() simulates a path of [CramerLundbergCapitalInjections](#) model until one of the following conditions is met: (1) the process is ruined, (2) max_time_horizon is achieved, (3) the elapsed time of the simulation is greater than max_simulation_time.

Usage

```
## S4 method for signature 'CramerLundbergCapitalInjections'
simulate_path(model,
  max_time_horizon = NULL, max_simulation_time = NULL, seed = NULL)
```

Arguments

model an S4 object of [CramerLundbergCapitalInjections](#) class.

max_time_horizon a length one numeric vector specifying the maximum time horizon, until with the process will be simulated. Default: Inf.

max_simulation_time a length one numeric vector indicating the maximum allowed time of simulation. The value should be specified in seconds. Default: Inf.

seed an optional arbitrary length numeric vector specifying the seed. If provided, the .Random.seed in .GlobalEnv is set to its value.

Value

[PathCramerLundbergCapitalInjections](#)

Warning

Setting both max_time_horizon and max_simulation_time to Inf might be dangerous. In this case, the only stopping condition is a ruin of the process, which might not happen.

Examples

```
model <- CramerLundbergCapitalInjections(
  initial_capital = 10,
  premium_rate = 1,
  claim_poisson_arrival_rate = 1,
  claim_size_generator = rexp,
  claim_size_parameters = list(rate = 1),
  capital_injection_poisson_rate = 1,
```

```

capital_injection_size_generator = rexp,
capital_injection_size_parameters = list(rate = 2)
)

path <- simulate_path(model = model, max_time_horizon = 10)

```

simulate_path, SparreAndersen-method

Simulates a path of a Sparre Andersen model

Description

simulate_path() simulates a path of [SparreAndersen](#) model until one of the following conditions is met: (1) the process is ruined, (2) max_time_horizon is achieved, (3) the elapsed time of the simulation is greater than max_simulation_time.

Usage

```

## S4 method for signature 'SparreAndersen'
simulate_path(model, max_time_horizon = NULL,
max_simulation_time = NULL, seed = NULL)

```

Arguments

model	an S4 object of SparreAndersen class.
max_time_horizon	a length one numeric vector specifying the maximum time horizon, until with the process will be simulated. Default: Inf.
max_simulation_time	a length one numeric vector indicating the maximum allowed time of simulation. The value should be specified in seconds. Default: Inf.
seed	an optional arbitrary length numeric vector specifying the seed. If provided, the .Random.seed in .GlobalEnv is set to its value.

Value

[PathSparreAndersen](#)

Warning

Setting both max_time_horizon and max_simulation_time to Inf might be dangerous. In this case, the only stopping condition is a ruin of the process, which might not happen.

Examples

```

model <- SparreAndersen(initial_capital = 10,
                        premium_rate = 1,
                        claim_interarrival_generator = rexp,
                        claim_interarrival_parameters = list(rate = 2),
                        claim_size_generator = rexp,
                        claim_size_parameters = list(rate = 1))

path <- simulate_path(model = model, max_time_horizon = 10)

```

```
simulate_path,SparreAndersenCapitalInjections-method
```

Simulates a path of a Sparre Andersen model's extension with capital injections

Description

simulate_path() simulates a path of [SparreAndersenCapitalInjections](#) model until one of the following conditions is met: (1) the process is ruined, (2) max_time_horizon is achieved, (3) the elapsed time of the simulation is greater than max_simulation_time.

Usage

```

## S4 method for signature 'SparreAndersenCapitalInjections'
simulate_path(model,
              max_time_horizon = NULL, max_simulation_time = NULL, seed = NULL)

```

Arguments

model	an S4 object of SparreAndersenCapitalInjections class.
max_time_horizon	a length one numeric vector specifying the maximum time horizon, until with the process will be simulated. Default: Inf.
max_simulation_time	a length one numeric vector indicating the maximum allowed time of simulation. The value should be specified in seconds. Default: Inf.
seed	an optional arbitrary length numeric vector specifying the seed. If provided, the .Random.seed in .GlobalEnv is set to its value.

Value

[PathSparreAndersenCapitalInjections](#)

Warning

Setting both max_time_horizon and max_simulation_time to Inf might be dangerous. In this case, the only stopping condition is a ruin of the process, which might not happen.

Examples

```

model <- SparreAndersenCapitalInjections(
  initial_capital = 10,
  premium_rate = 1,
  claim_interarrival_generator = rexp,
  claim_interarrival_parameters = list(rate = 1),
  claim_size_generator = rexp,
  claim_size_parameters = list(rate = 1),
  capital_injection_interarrival_generator = rexp,
  capital_injection_interarrival_parameters = list(rate = 1),
  capital_injection_size_generator = rexp,
  capital_injection_size_parameters = list(rate = 2)
)

path <- simulate_path(model = model, max_time_horizon = 10)

```

SparreAndersen

Constructs an object of SparreAndersen S4 class

Description

SparreAndersen() constructs an object of SparreAndersen S4 class.

Usage

```

SparreAndersen(initial_capital = NULL, premium_rate = NULL,
  claim_interarrival_generator = NULL, claim_interarrival_parameters = NULL,
  claim_size_generator = NULL, claim_size_parameters = NULL)

```

Arguments

initial_capital a length one numeric non-negative vector specifying an initial capital. Default: 0.

premium_rate a length one numeric non-negative vector specifying a premium rate. Default: 1.

claim_interarrival_generator a function indicating the random generator of claims' interarrival times. Default: rexp.

claim_interarrival_parameters a named list containing parameters for the random generator of claims' interarrival times. Default: list(rate = 1).

claim_size_generator a function indicating the random generator of claims' sizes. Default: rexp.

claim_size_parameters a named list containing parameters for the random generator of claims' sizes. Default: list(rate = 1).

Details

The function constructs an object of a formal S4 class `SparreAndersen`, a representation of an extension of Cramer-Lundberg model that allows for non-exponential interarrival times and defined as follows:

$$X(t) = u + ct - \sum_{i=1}^{N(t)} Y_i,$$

where u is the initial capital (`initial_capital`), c is the premium rate (`premium_rate`), $N(t)$ is the renewal process defined by distribution of interarrival times (`claim_interarrival_generator` and `claim_interarrival_parameters`), Y_i are iid claim sizes (`claim_size_generator` and `claim_size_parameters`).

Value

An object of `SparreAndersen` class.

References

- Andersen, E. Sparre. *On the collective theory of risk in case of contagion between claims*. Transactions of the XVth International Congress of Actuaries, 2(6), 1957.
- Thorin O. *Some Comments on the Sparre Andersen Model in the Risk Theory*. ASTIN Bulletin: The Journal of the IAA, 8(1):104-125, 1974.

See Also

[CramerLundberg](#), [CramerLundbergCapitalInjections](#), [link{SparreAndersenCapitalInjections}](#).

Examples

```
model <- SparreAndersen(
  initial_capital = 10,
  premium_rate = 1,
  claim_interarrival_generator = rexp,
  claim_interarrival_parameters = list(rate = 1),
  claim_size_generator = rexp,
  claim_size_parameters = list(rate = 1)
)
```

`SparreAndersen-class` *A formal S4 class SparreAndersen*

Description

A formal S4 class representation of classical Sparre Andersen model.

Details

The model is defined as follows:

$$X(t) = u + ct - \sum_{i=1}^{N(t)} Y_i,$$

where u is the initial capital (`initial_capital`), c is the premium rate (`premium_rate`), $N(t)$ is the renewal process defined by distribution of interarrival times (`claim_interarrival_generator` and `claim_interarrival_parameters`), Y_i are iid claim sizes (`claim_size_generator` and `claim_size_parameters`).

Objects of class can be created only by using the constructor [SparreAndersen](#).

Slots

`initial_capital` a length one numeric non-negative vector specifying an initial capital.

`premium_rate` a length one numeric non-negative vector specifying a premium rate.

`claim_interarrival_generator` a function indicating the random generator of claims' interarrival times.

`claim_interarrival_parameters` a named list containing parameters for the random generator of claims' interarrival times.

`claim_size_generator` a function indicating the random generator of claims' sizes.

`claim_size_parameters` a named list containing parameters for the random generator of claims' sizes.

References

- Andersen, E. Sparre. *On the collective theory of risk in case of contagion between claims*. Transactions of the XVth International Congress of Actuaries, 2(6), 1957.
- Thorin O. *Some Comments on the Sparre Andersen Model in the Risk Theory*. ASTIN Bulletin: The Journal of the IAA, 8(1):104-125, 1974.

See Also

[SparreAndersen](#)

SparreAndersenCapitalInjections

Constructs an object of SparreAndersenCapitalInjections S4 class

Description

`SparreAndersenCapitalInjections()` constructs an object of `SparreAndersenCapitalInjections` S4 class.

Usage

```
SparreAndersenCapitalInjections(initial_capital = NULL, premium_rate = NULL,
  claim_interarrival_generator = NULL, claim_interarrival_parameters = NULL,
  claim_size_generator = NULL, claim_size_parameters = NULL,
  capital_injection_interarrival_generator = NULL,
  capital_injection_interarrival_parameters = NULL,
  capital_injection_size_generator = NULL,
  capital_injection_size_parameters = NULL)
```

Arguments

`initial_capital` a length one numeric non-negative vector specifying an initial capital. Default: 0.

`premium_rate` a length one numeric non-negative vector specifying a premium rate. Default: 1.

`claim_interarrival_generator` a function indicating the random generator of claims' interarrival times. Default: `rexp`.

`claim_interarrival_parameters` a named list containing parameters for the random generator of claims' interarrival times. Default: `list(rate = 1)`.

`claim_size_generator` a function indicating the random generator of claims' sizes. Default: `rexp`.

`claim_size_parameters` a named list containing parameters for the random generator of claims' sizes. Default: `list(rate = 1)`.

`capital_injection_interarrival_generator` a function indicating the random generator of capital injections' interarrival times. Default: `rexp`.

`capital_injection_interarrival_parameters` a named list containing parameters for the random generator of capital injections' interarrival times. Default: `list(rate = 1)`.

`capital_injection_size_generator` a function indicating the random generator of capital injections' sizes. Default: `rexp`.

`capital_injection_size_parameters` a named list containing parameters for the random generator of capital injections' sizes. Default: `list(rate = 1)`.

Details

The function constructs an object of a formal S4 class `SparreAndersenCapitalInjections`, a representation of an extension of Sparre Andersen model that allows for positive jumps and defined as follows:

$$X(t) = u + ct + \sum_{k=1}^{N^{(+)}(t)} Y_k^{(+)} - \sum_{i=1}^{N^{(-)}(t)} Y_i^{(-)}$$

where u is the initial capital (`initial_capital`), c is the premium rate (`premium_rate`), $N^{(+)}(t)$ is the renewal process of positive jumps (capital injections) defined by distribution of interarrival times (`capital_injection_interarrival_generator` and `capital_injection_interarrival_parameters`), $Y_k^{(+)}$ are iid capital injections' sizes (`capital_injection_size_generator` and `capital_injection_size_parameters`), $N^{(-)}(t)$ is the renewal process of claims defined by distribution of interarrival times (`claim_interarrival_generator` and `claim_interarrival_parameters`), $Y_i^{(-)}$ are iid claim sizes (`claim_size_generator` and `claim_size_parameters`).

Value

An object of [SparreAndersenCapitalInjections](#) class.

References

Breuera L., Badescu A. L. *A generalised Gerber Shiu measure for Markov-additive risk processes with phase-type claims and capital injections*. Scandinavian Actuarial Journal, 2014(2): 93-115, 2014.

See Also

[CramerLundberg](#), [CramerLundbergCapitalInjections](#), [link{SparreAndersen}](#).

Examples

```
model <- SparreAndersenCapitalInjections(
  initial_capital = 10,
  premium_rate = 1,
  claim_interarrival_generator = rexp,
  claim_interarrival_parameters = list(rate = 1),
  claim_size_generator = rexp,
  claim_size_parameters = list(rate = 1),
  capital_injection_interarrival_generator = rexp,
  capital_injection_interarrival_parameters = list(rate = 1),
  capital_injection_size_generator = rexp,
  capital_injection_size_parameters = list(rate = 1)
)
```

SparreAndersenCapitalInjections-class

A formal S4 class SparreAndersenCapitalInjections

Description

A formal S4 class representation of Sparre Andersen's extension that includes capital injections.

Details

The model is defined as follows:

$$X(t) = u + ct + \sum_{k=1}^{N^{(+)}(t)} Y_k^{(+)} - \sum_{i=1}^{N^{(-)}(t)} Y_i^{(-)}$$

where u is the initial capital (`initial_capital`), c is the premium rate (`premium_rate`), $N^{(+)}(t)$ is the renewal process of positive jumps (capital injections) defined by distribution of interarrival times (`capital_injection_interarrival_generator` and `capital_injection_interarrival_parameters`), $Y_k^{(+)}$ are iid capital injections' sizes (`capital_injection_size_generator` and `capital_injection_size_parameters`), $N^{(-)}(t)$ is the renewal process of claims defined by distribution of interarrival times (`claim_interarrival_generator` and `claim_interarrival_parameters`), $Y_i^{(-)}$ are iid claim sizes (`claim_size_generator` and `claim_size_parameters`).

Objects of class can be created only by using the constructor [SparreAndersenCapitalInjections](#).

Slots

`initial_capital` a length one numeric non-negative vector specifying an initial capital.

`premium_rate` a length one numeric non-negative vector specifying a premium rate.

`claim_interarrival_generator` a function indicating the random generator of claims' interarrival times.

`claim_interarrival_parameters` a named list containing parameters for the random generator of claims' interarrival times.

`claim_size_generator` a function indicating the random generator of claims' sizes.

`claim_size_parameters` a named list containing parameters for the random generator of claims' sizes.

`capital_injection_interarrival_generator` a function indicating the random generator of capital injections' interarrival times.

`capital_injection_interarrival_parameters` a named list containing parameters for the random generator of capital injections' interarrival times.

`capital_injection_size_generator` a function indicating the random generator of capital injections' sizes.

`capital_injection_size_parameters` a named list containing parameters for the random generator of capital injections' sizes.

References

Breuera L., Badescu A. L. *A generalised Gerber Shiu measure for Markov-additive risk processes with phase-type claims and capital injections*. Scandinavian Actuarial Journal, 2014(2): 93-115, 2014.

See Also

[SparreAndersenCapitalInjections](#)

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