Package 'EstSimPDMP'

February 19, 2015

Type Package

Title Estimation and Simulation for PDMPs

Version 1.2

Date 2014-11-25

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Description

This package deals with the estimation of the jump rate for piecewise-deterministic Markov processes (PDMPs), from only one observation of the process within a long time. The main functions provide an estimate of this function. The state space may be discrete or continuous. The associated paper has been published in Scandinavian Journal of Statistics and is given in references. Other functions provide a method to simulate random variables from their (conditional) hazard rate, and then to simulate PDMPs.

License GPL (>= 2)

NeedsCompilation no

Repository CRAN

Date/Publication 2014-11-26 18:53:19

R topics documented:

EstSimPDMP-package — *Nonparametric estimation of the jump rate and simulation for piecewise-deterministic Markov processes*

Description

This package deals with the estimation of the jump rate for piecewise-deterministic Markov processes (PDMPs), from only one observation of the process within a long time. The main functions provide an estimate of this function. The state space may be discrete or continuous. The associated paper is given in References. Other functions provide a method to simulate random variables from their (conditional) hazard rate, and then to simulate PDMPs.

Details

Package:	EstSimPDMP
Type:	Package
Version:	1.2
Date:	Nov 2014
License:	GPL (>=2)

Simu.Cond.HR(n,lambda,x)

CondPdf.DC.interval(data,x,tmin,tmax,N)

CondPdf.CC.interval(data,x,epsilon,tmin,tmax,N)

Author(s)

Romain AZAIS <romain.azais@gmail.com>

References

Azais R., Dufour F., and Gegout-Petit A. *Nonparametric estimation of the conditional distribution of the inter-jumping times for piecewise-deterministic Markov processes* Scandinavian Journal of Statistics, 2014.

See Also

CondPdf.DC.interval, CondPdf.CC.interval, Simu.HR, Simu.Cond.HR

Examples

```
# Simu.Cond.HR
example<-function(x,t){
sqrt(sum(x^2))+t
}
# Simulations of 50 iid random variables with hazard rate=example given x=3
```

```
Simu.Cond.HR(50,example,3)

# Simulations of 50 iid random variables with hazard rate=example given x=0.5
# Simu.Cond.HR(50,example,0.5)


# CondPdf.DC.interval

# Simulation of a PDMP with discrete state space
dat<-Simu.PDMP.DC(1,500,verbose=FALSE)
# Estimation of the conditional density given state=2
CondPdf.DC.interval(dat,2,0.4,5.5,70,alpha=1/4,bound=5.8)

tmin<-0.4
tmax<-5.5
N<-70
a<-(N*tmin):(N*tmax)
a<-a/N

# Conditional density given state=2
gr<-exp(-a)
# Theoretical conditional pdf
points(a,gr,"l",col="blue")


# CondPdf.CC.interval

# Simulation of a PDMP with continuous state space
dat<-Simu.PDMP(2.3,500,verbose=FALSE)
# Estimation of the conditional density given state=1.8
CondPdf.CC.interval(dat,1.8,0.3,0.5,7.5,70,h=1/3,bound=7.8)

tmin<-0.5
tmax<-7.5
N<-70
a<-tmin:N*tmax
a<-a/N

x<-1.8
# Theoretical conditional pdf given state=1.8
grid<-(1/(1+x))*exp(-(1/(1+x))*a)
points(a,grid,"l",col="blue")
```

CHR *Nelson-Aalen estimator*

Description

This function computes the Nelson-Aalen estimator of the cumulative hazard rate from independent positive observations.

Usage

```
CHR(dat,t)
```

Arguments

`dat`	data from which the estimator is to be computed.
`t`	the estimator is computed at time t.

Author(s)

Romain Azais

References

Andersen P.K., Borgan O., Gill R.D., Keiding N. *Statistical models based on counting processes* Springer Series in Statistics. Springer-Verlag, New-York (1993)

See Also

`plotCHR`

Examples

```
# CHR

# Simulation of 50 independent exponential random variables
dat<-rexp(50,1)

# Nelson-Aalen estimator of cumulative hazard rate at time 2
CHR(dat,2)
```

`CondPdf.CC.interval` *Estimation of the density associated to the jump rate for piecewise-deterministic Markov processes (continuous state space)*

Description

This is the main function of the package EstSimPDMP. It computes the estimation of the density associated to the jump rate for a piecewise-deterministic Markov process (PDMP) whose state space is continuous. Details about the estimator are given in the paper mentioned in References.

Usage

```
CondPdf.CC.interval(dat,x,epsilon,tmin,tmax,nbre,h,alpha,verbose,bound)
```

Arguments

`dat`	data from which the estimator is to be computed. It corresponds to the observation of a PDMP within a long time. dat is a matrix such that the last column contains the interarrival times, while the other columns contain the post-jump locations of the process.
`x`	the conditional probability density function is estimated given state is around x.
`epsilon`	the probability density function is estimated given the distance between state and x is less than epsilon. If epsilon is small, this is an approximation of the exact density.
`tmin`	the probability density function is estimated between tmin and tmax.
`tmax`	the probability density function is estimated between tmin and tmax. In addition, tmax must be less than bound.
`nbre`	size of the grid plot.
`h`	bandwith
`alpha`	strictly positive real number. If h is NULL, the bandwith is 1/n^alpha where n is the number of data.
`verbose`	if TRUE, add a plot between tmin and tmax.
`bound`	the estimator is computed as an integral between the times 0 and bound. bound must be less than the deterministic exit time function tstar computed at state x

Author(s)

Romain Azais

References

Azais R., Dufour F., and Gegout-Petit A. *Nonparametric estimation of the conditional distribution of the inter-jumping times for piecewise-deterministic Markov processes* Scandinavian Journal of Statistics, 2014.

See Also

`CondPdf.DC.interval`, `Simu.PDMP`

Examples

```
# CondPdf.CC.interval

# Simulation of a PDMP with continuous state space
dat<-Simu.PDMP(2.3,500,verbose=FALSE)

# Estimation of the conditional density given state=1.8
CondPdf.CC.interval(dat,1.8,0.3,0.5,7.5,70,h=1/3,bound=7.8)

tmin<-0.5
tmax<-7.5
N<-70
```

```
a<-tmin:N*tmax
a<-a/N

x<-1.8
# Theoretical conditional pdf given state=1.8
grid<-(1/(1+x))*exp(-(1/(1+x))*a)
points(a,grid,"l",col="blue")
```

CondPdf.DC *Estimation of the density associated to the jump rate for piecewise-deterministic Markov processes (discrete state space)*

Description

This function computes the estimation of the density associated to the jump rate for a piecewise-deterministic Markov process whose state space is finite. The estimator is given in the paper mentioned in References.

Usage

```
CondPdf.DC(dat,x,t,h,alpha,bound)
```

Arguments

dat	data from which the estimator is to be computed. It corresponds to the observation of a process within a long time. dat is a matrix such that the last column contains the interarrival times, while the other columns contain the states.
x	the conditional probability density function is estimated given state=x.
t	the conditional probability density function is estimated at time t. In addition, t must be less than bound.
h	bandwith
alpha	strictly positive real number. If h is NULL, the bandwith is 1/n^alpha where n is the number of data.
bound	the estimator is computed as an integral between the times 0 and bound. bound must be less than the deterministic exit time function tstar computed at state x

Author(s)

Romain Azais

References

Azais R., Dufour F., and Gegout-Petit A. *Nonparametric estimation of the conditional distribution of the inter-jumping times for piecewise-deterministic Markov processes* Scandinavian Journal of Statistics, 2014.

See Also

CondPdf.DC.interval, Simu.PDMP.DC

Examples

```
# CondPdf.DC

# Simulation of a PDMP with discrete state space
dat<-Simu.PDMP.DC(1,200,verbose=FALSE)

# Estimation of the conditional density given state=2 at time 2
CondPdf.DC(dat,2,2,bound=5.8)
```

CondPdf.DC.interval — *Estimation of the density associated to the jump rate for piecewise-deterministic Markov processes (discrete state space)*

Description

This function computes the estimation of the density associated to the jump rate for a piecewise-deterministic Markov (PDMP) process whose state space is finite between the two times tmin and tmax. The estimator is given in the paper mentioned in References.

Usage

```
CondPdf.DC.interval(dat,x,tmin,tmax,nbre,h,alpha,verbose,bound)
```

Arguments

dat	data from which the estimator is to be computed. It corresponds to the observation of a PDMP within a long time. dat is a matrix such that the last column contains the interarrival times, while the other columns contain the states.
x	the conditional probability density function is estimated given state=x.
tmin	the conditional probability density function is estimated between tmin and tmax given state=x.
tmax	the conditional probability density function is estimated between tmin and tmax given state=x. In addition, tmax must be less than bound.
nbre	size of the grid plot.
h	bandwith
alpha	strictly positive real number. If h is NULL, the bandwith is 1/n^alpha where n is the number of data.
verbose	if TRUE, add a plot between tmin and tmax.
bound	the estimator is computed as an integral between the times 0 and bound. bound must be less than the deterministic exit time function tstar computed at state x.

Author(s)

Romain Azais

References

Azais R., Dufour F., and Gegout-Petit A. *Nonparametric estimation of the conditional distribution of the inter-jumping times for piecewise-deterministic Markov processes* Scandinavian Journal of Statistics, 2014.

See Also

CondPdf.DC, Simu.PDMP.DC

Examples

```
# CondPdf.DC.interval

# Simulation of a PDMP with discrete state space
dat<-Simu.PDMP.DC(1,500,verbose=FALSE)

# Estimation of the conditional density given state=2
CondPdf.DC.interval(dat,2,0.4,5.5,70,alpha=1/4,bound=5.8)

tmin<-0.4
tmax<-5.5
N<-70
a<-(N*tmin):(N*tmax)
a<-a/N

# Conditional density given state=2
gr<-exp(-a)
# Theoretical conditional pdf
points(a,gr,"l",col="blue")
```

HR — *Estimator of the hazard rate function by a kernel method*

Description

The function computes the estimator of the hazard rate function from positive data. This is the smoothed estimator given in the article written by Ramlau-Hansen. The kernel must be continuous with support [-1,1]. The chosen kernel is the Epanechnikov kernel.

Usage

```
HR(dat,t,h,alpha,bound)
```

Arguments

- `dat` — data from which the estimator is to be computed.
- `t` — the estimator is computed at time t.
- `h` — bandwith
- `alpha` — strictly positive real number. If h is NULL, the bandwith is 1/n^alpha where n is the number of data.
- `bound` — the estimator is computed as an integral between the times 0 and bound. bound may be the deterministic time of censorship. The default value is Inf: it means that there is no censorship.

Author(s)

Romain Azais

References

Ramlau-Hansen H. *Smoothing counting process intensities by means of kernel functions* The Annals of Statistics, Vol. 11, No.2, (1983) 453-466

Andersen P.K., Borgan O., Gill R.D., Keiding N. *Statistical models based on counting processes* Springer Series in Statistics. Springer-Verlag, New-York (1993)

See Also

`CHR`, `plotHR`

Examples

```
# HR

# Simulation of 50 independent exponential random variables
dat<-rexp(50,1)

# Estimation of the exponential hazard rate at time 0.4
HR(dat,0.4)
```

`plotCHR` *Plot the Nelson-Aalen estimator*

Description

Function for computing and plotting the Nelson-Aalen estimator of the cumulative hazard rate between two times.

Usage

```
plotCHR(dat,tmin,tmax,N)
```

Arguments

`dat`	data from which the estimator is to be computed.
`tmin`	the estimator is computed from time tmin to time tmax.
`tmax`	the estimator is computed from time tmin to time tmax. In addition, tmax is greater than tmin.
`N`	size of the grid plot.

Author(s)

Romain Azais

References

Andersen P.K., Borgan O., Gill R.D., Keiding N. *Statistical models based on counting processes* Springer Series in Statistics. Springer-Verlag, New-York (1993)

See Also

CHR

Examples

```
# plotCHR

# Simulation of 50 independent exponential random variables
dat<-rexp(50,1)

# Nelson-Aalen estimator of cumulative hazard rate between 0 and 2
plotCHR(dat,0,2,20)

# Theoretical cumulative hazard rate
points(0:2,0:2,col="blue",type="l")
```

---

plotHR *Plot the estimator of the hazard rate computed by the function HR*

Description

Function for plotting the hazard rate estimator computed by the function HR between two times.

Usage

```
plotHR(dat,tmin,tmax,N,h,alpha,bound)
```

Arguments

- `dat` data from which the estimator is to be computed.
- `tmin` the estimator is computed from time tmin to time tmax. tmax is greater than tmin.
- `tmax` the estimator is computed from time tmin to time tmax. tmax is greater than tmin. In addition, tmax must be less than bound.
- `N` size of the grid plot.
- `h` bandwith.
- `alpha` strictly positive real number. If h is NULL, the bandwith is 1/n^alpha where n is the number of data.
- `bound` the estimator is computed as an integral between the times 0 and bound. bound may be the deterministic time of censorship. The default value is Inf: it means that there is no censorship. Moreover, tmax must be less than bound.

Author(s)

Romain Azais

References

Ramlau-Hansen H. *Smoothing counting process intensities by means of kernel functions* The Annals of Statistics, Vol. 11, No.2, (1983) 453-466

Andersen P.K., Borgan O., Gill R.D., Keiding N. *Statistical models based on counting processes* Springer Series in Statistics. Springer-Verlag, New-York (1993)

See Also

HR

Examples

```
# plotHR

# Simulation of 100 independent exponential random variables
dat<-rexp(100,1)

# Estimation of the exponential hazard rate between 0 and 2
plotHR(dat,1,2,100,h=0.2)

# Theoretical hazard rate of exponential distribution
points(1:2,c(1,1),col="blue",type="l")
```

Simu.Cond.HR — *Simulation of random variables from their conditional hazard rate function*

Description

This function computes simulations of random variables from their conditional hazard rate function.

Usage

```
Simu.Cond.HR(N,lambda,x,verbose)
```

Arguments

N	number of simulations.
lambda	conditional hazard rate function (can be computed in a vector of times).
x	the hazard rate function of the simulations is lambda(x,.).
verbose	if TRUE, add a histogram of the simulations.

Author(s)

Romain Azais

See Also

Simu.HR

Examples

```
# Simu.Cond.HR
example<-function(x,t){
sqrt(sum(x^2))+t
}

# Simulations of 50 iid random variables with hazard rate=example given x=3
Simu.Cond.HR(50,example,3)

# Simulations of 50 iid random variables with hazard rate=example given x=0.5
# Simu.Cond.HR(50,example,0.5)
```

Simu.HR *Simulation of random variables from their hazard rate function*

Description

This function computes simulations of random variables from their chazard rate function.

Usage

```
Simu.HR(N,lambda,verbose)
```

Arguments

N	number of simulations.
lambda	hazard rate function (can be computed in a vector of times).
verbose	if TRUE, add a histogram of the simulations.

Author(s)

Romain Azais

See Also

Simu.Cond.HR

Examples

```
# Simu.HR

# Weibull distribution hazard rate function
example<-function(x){
x
}
# Simulation of 50 iid random variables with hazard rate=example
Simu.HR(50,example)
```

Simu.PDMP *Simulation of a piecewise-deterministic Markov process with continuous state space*

Description

This function computes a simulation of a particular piecewise-deterministic Markov process. The state space of the process is the interval]0,10[. This function is given for illustrating the function CondPdf.CC.interval.

Usage

```
Simu.PDMP(x0,T,verbose)
```

Arguments

`x0`	origin of the process.
`T`	number of simulated jumps.
`verbose`	if TRUE, add a plot of the simulation.

Author(s)

Romain Azais

See Also

`CondPdf.CC.interval`, `Simu.PDMP.DC`

Examples

```
Simu.PDMP(2.4,20)
```

`Simu.PDMP.DC` *Simulation of a piecewise-deterministic Markov process with discrete state space*

Description

This function computes a simulation of a particular piecewise-deterministic Markov process. The state space of the process is the set (1,2,3). This function is given for illustrating the function CondPdf.DC.interval.

Usage

```
Simu.PDMP.DC(x0,T,verbose)
```

Arguments

`x0`	origin of the process.
`T`	number of simulated jumps.
`verbose`	if TRUE, add a plot of the simulation.

Author(s)

Romain Azais

See Also

`CondPdf.DC.interval`

Examples

```
Simu.PDMP.DC(1,50)
```

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