Package ‘AdapSamp’

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Title Adaptive Sampling Algorithms

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Description For distributions whose probability density functions are log-concave, the adaptive rejection sampling algorithm can be used to build envelope functions for sampling. For others, we can use the modified adaptive rejection sampling algorithm, the concave-convex adaptive rejection sampling algorithm and the adaptive slice sampling algorithm. So we designed an R package mainly including 4 functions: rARS(), rMARS(), rCCARS() and rASS(). These functions can realize sampling based on the algorithms above.

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R topics documented:

rARS *Adaptive Rejection Sampling Algorithm*

Description

rARS generates a sequence of random numbers using the adaptive rejection sampling algorithm.

Usage

```
rARS(n, formula, min = -Inf, max = Inf, sp)
```

Arguments

n	Desired sample size;
formula	Kernal of the target density;
min, max	Domain including positive and negative infinity of the target distribution;
sp	Supporting set.

Author(s)

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Examples

```
# Example 1: Standard normal distribution
x1 <- rARS(100,"exp(-x^2/2)",-Inf,Inf,c(-2,2))

# Example 2: Truncated normal distribution
x2 <- rARS(100,"exp(-x^2/2)",-2.1,2.1,c(-2,2))

# Example 3: Normal distribution with mean=2 and sd=2
x3 <- rARS(100,"exp(-(x-2)^2/(2*4))",-Inf,Inf,c(-3,3))

# Example 4: Exponential distribution with rate=3
x4 <- rARS(100,"exp(-3*x)",0,Inf,c(2,3,100))

# Example 5: Beta distribution with alpha=3 and beta=4
x5 <- rARS(100,"x^2*(1-x)^3",0,1,c(0.4,0.6))

# Example 6: Gamma distribution with alpha=5 and lambda=2
x6 <- rARS(100,"x^(5-1)*exp(-2*x)",0,Inf,c(1,10))

# Example 7: Student distribution with df=10
x7 <- rARS(100,"(1+x^2/10)^(-(10+1)/2)",-Inf,Inf,c(-10,2))

# Example 8: F distribution with m=10 and n=5
x8 <- rARS(100,"x^(10/2-1)/(1+10/5*x)^(15/2)",0,Inf,c(3,10))
```

```
# Example 9:Cauchy distribution
x9 <- rARS(100,"1/(1+(x-1)^2)",-Inf,Inf,c(-2,2,10))

# Example 10:Rayleigh distribution with lambda=1
x10 <- rARS(100,"2*x*exp(-x^2)",0,Inf,c(0.01,10))
```

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rASS *Adaptive Slice Sampling Algorithm With Stepping-Out Procedures*

Description

rASS generates a sequence of random numbers by the adaptive slice sampling algorithm with stepping-out procedures.

Usage

```
rASS(n, x0 = 0, formula, w = 3)
```

Arguments

n	Desired sample size;
x0	Initial value;
formula	Target density function p(x);
w	Length of the coverage interval.

Author(s)

Dong Zhang <dzhang0716@126.com>

References

Neal R M. Slice sampling - Rejoinder[J]. Annals of Statistics, 2003, 31(3):758-767.

Examples

```
# Example 1: Sampling from exponential distribution with bounded domain
x<-rASS(100,-1,"1.114283*exp(-(4-x^2)^2)",3)
plot(density(x))
```

rCCARS *Concave-Convex Adaptive Rejection Sampling Algorithm*

Description

rCCARS generates a sequence of random numbers by the concave-convex adaptive rejection sampling algorithm from target distributions with bounded domain.

Usage

```
rCCARS(n, cvformula, ccformula, min, max, sp)
```

Arguments

`n`	Desired sample size;
`cvformula, ccformula`	Convex and concave decompositions for -ln(p(x)) where p(x) is the kernal of target density;
`min, max`	Domain except positive and negative infinity;
`sp`	Supporting set

Details

Strictly speaking, the concave-convex adaptive rejection sampling algorithm can generate samples from target distributions who have bounded domains. For distributions with unbounded domain, rCCARS can also be used for sampling approximately. For example, if we want draw a sequence from N(0,1) by the concave-convex adaptive rejection sampling algorithm. We know that X~N(0,1) has a so small probability in two tails that we can ingore the parts at both ends. Pr(X>20)=P(X<-20)=2.753624e-89, therefore we can get random numbers approximately from N(0,1) with the bound [-20,20]. Also, you can make this bound large enough to reduce sampling error.

Author(s)

Dong Zhang <dzhang0716@126.com>

References

Teh Y W. Concave-Convex Adaptive Rejection Sampling[J]. Journal of Computational & Graphical Statistics, 2011, 20(3):670-691.

Examples

```
# Example 1: Generalized inverse bounded gaussian distribution with lambda=-1 and a=b=2
x<-rCCARS(100,"x+x^-1","2*log(x)",0.001,100,1)
hist(x,breaks=20,probability =TRUE);lines(density(x,bw=0.1),col="red",lwd=2,lty=2)
f <- function(x) {x^(-2)*exp(-x-x^(-1))/0.2797318}
```

```
lines(seq(0,5,0.01),f(seq(0,5,0.01)),lwd=2,lty=3,col="blue")

#The following examples are also available;
#But it may take a few minutes to run them.

# Example 2: Expontional bounded distribution
# x<-rCCARS(1000,"x^4","-8*x^2+16",-3,4,c(-2,1))
# hist(x,breaks=30,probability=TRUE);lines(density(x,bw=0.05),col="blue",lwd=2,lty=2)
# f <- function(x) exp(-(x^2-4)^2)/ 0.8974381
# lines(seq(-3,4,0.01),f(seq(-3,4,0.01)),col="red",lty=3,lwd=2)

# Example 3: Makeham bounded distribution
# x<-rCCARS(1000,"x+1/log(2)*(2^x-1)","-log(1+2^x)",0,5,c(1,2,3))
# hist(x,breaks=30,probability=TRUE);lines(density(x,bw=0.05),col="blue",lwd=2,lty=2)
# f <- function(x){(1+2^x)*exp(-x-1/log(2)*(2^x-1))}
# lines(seq(0,5,0.01),f(seq(0,5,0.01)),col="red",lty=3,lwd=2,type="l")
```

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rMARS *Modified Adaptive Rejection Sampling Algorithm*

Description

rMARS generates a sequence of random numbers using the modified adaptive rejection sampling algorithm.

Usage

```
rMARS(n, formula, min = -Inf, max = Inf, sp, infp, m = 10^(-4))
```

Arguments

n	Desired sample size;
formula	Kernel of the target distribution;
min, max	Domain including positive and negative infinity of the target distribution;
sp	Supporting set;
infp	Inflexion set;
m	A parameter for judging concavity and convexity in a certain interval.

Author(s)

Dong Zhang <dzhang0716@126.com>

References

Martino L, Miguez J. A generalization of the adaptive rejection sampling algorithm[J]. Statistics & Computing, 2011, 21(4):633-647.

Examples

```
# Example 1: Exponential distribution
x <- rMARS(100,"exp(-(4-x^2)^2)",-Inf,Inf, c(-2.5,0,2.5),c(-2/sqrt(3),2/sqrt(3)))
hist(x,probability=TRUE,xlim=c(-3,3),ylim=c(0,1.2),breaks=20)
lines(density(x,bw=0.05),col="blue")
f <- function(x)(exp(-(4-x^2)^2))
lines(seq(-3,3,0.01),f(seq(-3,3,0.01))/integrate(f,-3,3)[[1]],lwd=2,lty=2,col="red")

#The following examples are also available;
#But it may take a few minutes to run them.

# Example 2: Distribution with bounded domain
# x <- rMARS(1000,"exp(-(x^2-x^3))",-3,2,c(-1,1),1/3)
# hist(x,probability=TRUE,xlim=c(-3,2.5),ylim=c(0,1.2),breaks=20)
# lines(density(x,bw=0.2),col="blue")
# f <- function(x) exp(-(x^2-x^3))
# lines(seq(-3,2,0.01),f(seq(-3,2,0.01))/integrate(f,-3,2)[[1]],lwd=2,lty=2,col="red",type="l")


# Example 3: Weibull distribution with k=3 and lambda=1
# x <- rMARS(100,"3*x^2*exp(-x^3)",10^-15,Inf,c(0.01,1),(1/3)^(1/3),m=10^-4)
# hist(x,probability=TRUE,breaks=20,xlim=c(0,2))
# lines(density(x,bw=0.15),col="blue")
# f <- function(x) 3*x^2*exp(-x^3)
# lines(seq(0,2,0.01),f(seq(0,2,0.01)),lwd=2,lty=2,col="red",type="l")


# Example 4: Mixed normal distribution with p=0.3,m1=2,m2=8,sigma1=1,sigma2=2
# x <- rMARS(100,"0.3/sqrt(2*pi)*exp(-(x-2)^2/2)+(1-0.3)/sqrt(2*pi)/2*exp(-(x-8)^2/8)",-Inf,Inf,
# c(-6,-4,0,3,6,15),c(-5.120801,-3.357761,3.357761,5.120801),m=10^-8)
# hist(x,breaks=20,probability=TRUE);lines(density(x,bw=0.45),col="blue",lwd=2)
# f <- function(x)0.3/sqrt(2*pi)*exp(-(x-2)^2/2)+(1-0.3)/sqrt(2*pi)/2*exp(-(x-8)^2/8)
# lines(seq(0,14,0.01),f(seq(0,14,0.01)),lty=3,col="red",lwd=2 )
```

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