

# Package ‘DPtree’

June 19, 2018

**Title** Dirichlet-Based Polya Tree

**Version** 1.0.1

**Description** Contains functions to perform copula estimation  
by the non-parametric Bayesian method,  
Dirichlet-based Polya Tree. See Ning (2018) <doi:10.1080/00949655.2017.1421194>.

**Depends** R (>= 3.3.1)

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**RdMacros** Rdpack

**RoxygenNote** 6.0.1

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dDPTreeRealize	<i>The disitribution function for realized distribution from D-P tree.</i>
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**Description**

dDPTreeRealize returns the value of density function of realized distribution from D-P tree at certain given point on copula space.

**Usage**

```
dDPTreeRealize(d, x)
```

**Arguments**

d	A $2^m$ by $2^m$ matrix, m being the approximating level. Normalized measures for all $2^m$ by $2^m$ sub-partititons on copula space given by the realized distribution from D-P tree, as returned by DPTreeDensity.
x	An array of dimension n by 2. The points on copula space for density function evaluation. Should be between 0 and 1.

**Value**

An array of length n. The values of PDF of the input D-P tree distribution evaluated at the input points.

**References**

Ning S and Shephard N (2018). "A nonparametric Bayesian approach to copula estimation." *Journal of Statistical Computation and Simulation*, **88**(6), pp. 1081-1105. doi: [10.1080/00949655.2017.1421194](https://doi.org/10.1080/00949655.2017.1421194).

**Examples**

```
dDPTreeRealize(DPTreePMeanDensity(DPTreePrior(m=2, z=1)),c(0.5,0.5))
```

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DPTreeDensity	<i>Calculating sub-partition probabiltiy measures for a realized distribution from D-P tree.</i>
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**Description**

DPTreeDensity returns the probabiltiy measures in the finest sub-partitions of a realized distribution from D-P tree prior/posterior.

**Usage**

```
DPTreeDensity(Z)
```

**Arguments**

`Z` An array of dimension of  $2^m$  by  $2^m$  by  $m$ ,  $m$  being the approximation level. Realized  $Z$ 's for all partitions at each level, as returned by `RealizedDPTree`.

**Value**

A  $2^m$  by  $2^m$  matrix. Normalized measures for all  $2^m$  by  $2^m$  sub-partititons on copula space given by the realized distribution from D-P tree.

**References**

Ning S and Shephard N (2018). "A nonparametric Bayesian approach to copula estimation." *Journal of Statistical Computation and Simulation*, **88**(6), pp. 1081-1105. doi: [10.1080/00949655.2017.1421194](https://doi.org/10.1080/00949655.2017.1421194).

**Examples**

```
dp.rlz <- RealizeDPTree(DPTreePrior(m=2, z=1))
DPTreeDensity(dp.rlz)
```

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<code>DPTreePMeanDensity</code>	<i>Calculating sub-partition probabiltiy measures for the posterior mean distribution from D-P tree.</i>
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---

**Description**

`DPTreePMeanDensity` returns the probablity measures in the finest sub-partitions of the posterior mean from D-P tree.

**Usage**

```
DPTreePMeanDensity(prior)
```

**Arguments**

`prior` A list. D-P tree specification. Should be in same format as returned from `DPTreePrior` or `DPTreePosterior`.

**Value**

A  $2^m$  by  $2^m$  matrix. Normalized measures for all  $2^m$  by  $2^m$  sub-partititons on copula space given by the posterior mean distribution from D-P tree.

**References**

Ning S and Shephard N (2018). "A nonparametric Bayesian approach to copula estimation." *Journal of Statistical Computation and Simulation*, **88**(6), pp. 1081-1105. doi: [10.1080/00949655.2017.1421194](https://doi.org/10.1080/00949655.2017.1421194).

**Examples**

```
DPTreePMeanDensity(DPTreePrior(m=2, z=1))
```

---

DPTreePosterior      *D-P tree posterior updating from a single copula observation.*

---

**Description**

DPTreePosterior returns the D-P tree posterior given input copula data.

**Usage**

```
DPTreePosterior(x, prior, w = 1)
```

**Arguments**

x	An array of length 2. Single copula data observation. Each element should be between 0 and 1.
prior	A list. Should be in same format as returned from DPTreePrior.
w	A positive number. Weight of data for posterior updating. Default 1.

**Value**

A list.	
a	An array containing the hyperparameters of D-P trees.

**References**

Ning S and Shephard N (2018). “A nonparametric Bayesian approach to copula estimation.” *Journal of Statistical Computation and Simulation*, **88**(6), pp. 1081-1105. doi: [10.1080/00949655.2017.1421194](https://doi.org/10.1080/00949655.2017.1421194).

**Examples**

```
nsim = 1
rho = 0.9
data1 <- MASS::mvrnorm(n=nsim, mu=rep(0, 2), Sigma=matrix(c(1, rho, rho, 1), 2, 2))
data2 <- stats::pnorm(data1)
DPTreePosterior(x=data2, prior=DPTreePrior(m=4, z=1))
```

---

DPTreePosteriorMulti *D-P tree posterior updating from multiple copula observations.*

---

## Description

DPTreePosteriorMulti returns the D-P tree posterior given input copula data.

## Usage

```
DPTreePosteriorMulti(x, prior, w = 1)
```

## Arguments

**x** An array of dimension  $n$  by 2. Multiple copula data observations, with each row being a bivariate copula observation. All elements should be between 0 and 1.

**prior** A list. Should be in same format as returned from DPTreePrior.

**w** A positive number or an array of length  $n$ . Weight of data for posterior updating. Default 1.

## Value

A list.

**a** An array containing the hyperparameters of D-P trees.

## References

Ning S and Shephard N (2018). "A nonparametric Bayesian approach to copula estimation." *Journal of Statistical Computation and Simulation*, **88**(6), pp. 1081-1105. doi: [10.1080/00949655.2017.1421194](https://doi.org/10.1080/00949655.2017.1421194).

## Examples

```
nsim = 10
rho = 0.9
data1 <- MASS::mvrnorm(n=nsim, mu=rep(0, 2), Sigma=matrix(c(1, rho, rho, 1), 2, 2))
data2 <- stats::pnorm(data1)
DPTreePosteriorMulti(x=data2, prior=DPTreePrior(m=4, z=1))
```

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DPTreePrior

*Generating the standard D-P Tree prior*


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**Description**

DPTreePrior returns a standard D-P Tree prior based on specified hyperparameters.

**Usage**

```
DPTreePrior(m = 4, z = 1)
```

**Arguments**

**m** A positive integer. The finite approximation level for D-P tree. Default m=4.

**z** A positive number. On i-th level, the hyperparameter for D-P tree prior is  $z \times i^2$ . Default z=1.

**Value**

A list.

**a** An array containing the hyperparameters of D-P trees.

**References**

Ning S and Shephard N (2018). "A nonparametric Bayesian approach to copula estimation." *Journal of Statistical Computation and Simulation*, **88**(6), pp. 1081-1105. doi: [10.1080/00949655.2017.1421194](https://doi.org/10.1080/00949655.2017.1421194).

**Examples**

```
DPTreePrior(m=6, z=1)
```

---

pDPTreeRealize

*The disitribution function for realized distribution from D-P tree.*


---

**Description**

pDPTreeRealize returns the value of distribution function of realized distribution from D-P tree at certain given point on copula space.

**Usage**

```
pDPTreeRealize(d, x)
```

**Arguments**

- d** A  $2^m$  by  $2^m$  matrix,  $m$  being the approximating level. Normalized measures for all  $2^m$  by  $2^m$  sub-partitions on copula space given by the realized distribution from D-P tree, as returned by `DPTreeDensity`.
- x** An array of dimension  $n$  by 2. The points on copula space for distribution function evaluation. Should be between 0 and 1.

**Value**

An array of length  $n$ . The values of CDF of the input D-P tree distribution evaluated at the input points.

**References**

Ning S and Shephard N (2018). "A nonparametric Bayesian approach to copula estimation." *Journal of Statistical Computation and Simulation*, **88**(6), pp. 1081-1105. doi: [10.1080/00949655.2017.1421194](https://doi.org/10.1080/00949655.2017.1421194).

**Examples**

```
pDPTreeRealize(DPTreePMeanDensity(DPTreePrior(m=2, z=1)),c(0.5,0.5))
```

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RealizeDPTree	<i>Sampling a realized distribution from the D-P Tree.</i>
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---

**Description**

`RealizeDPTree` returns a realized (copula) distribution sampled from the input D-P Tree.

**Usage**

```
RealizeDPTree(prior)
```

**Arguments**

- prior** A list. Should be in same format as returned from `DPTreePrior`.

**Value**

An array of dimension  $2^m$  by  $2^m$  by  $m$ .  $m$  is the approximation level. Realized  $Z$ 's for all partitions at each level. Three dimensions represent two marginals, and the level respectively.

**References**

Ning S and Shephard N (2018). "A nonparametric Bayesian approach to copula estimation." *Journal of Statistical Computation and Simulation*, **88**(6), pp. 1081-1105. doi: [10.1080/00949655.2017.1421194](https://doi.org/10.1080/00949655.2017.1421194).

**Examples**

```
RealizeDPTree(DPTreePrior(m=2, z=1))
```

---

SampleDPTreeDensity    *Sample a copula observation from a realized distribution from D-P tree.*

---

**Description**

SampleDPTreeDensity returns a copula sample from a realized distribution from D-P tree.

**Usage**

```
SampleDPTreeDensity(nsam, d)
```

**Arguments**

nsam	A positive integer. The sample size.
d	A $2^m$ by $2^m$ matrix, m being the approximating level. Normalized measures for all $2^m$ by $2^m$ sub-partititons on copula space given by the realized distribution from D-P tree, as returned by DPTreeDensity.

**Value**

An array of dimension nsam by 2. The values of PDF of the input D-P tree distribution evaluated at the input points.

**References**

Ning S and Shephard N (2018). "A nonparametric Bayesian approach to copula estimation." *Journal of Statistical Computation and Simulation*, **88**(6), pp. 1081-1105. doi: [10.1080/00949655.2017.1421194](https://doi.org/10.1080/00949655.2017.1421194).

**Examples**

```
SampleDPTreeDensity(10, DPTreePMeanDensity(DPTreePrior(m=2, z=1)))
```



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