

tf.distributions.Exponential

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Class **Exponential**Inherits From: [Gamma](#)

Aliases:

- Class `tf.contrib.distributions.Exponential`
- Class `tf.distributions.Exponential`

Defined in [tensorflow/python/ops/distributions/exponential.py](#).See the guide: [Statistical Distributions \(contrib\) > Univariate \(scalar\) distributions](#)

Exponential distribution.

The Exponential distribution is parameterized by an event `rate` parameter.

Mathematical Details

The probability density function (pdf) is,

```
pdf(x; lambda, x > 0) = exp(-lambda x) / Z
Z = 1 / lambda
```

where `rate = lambda` and `Z` is the normalizaing constant.

The Exponential distribution is a special case of the Gamma distribution, i.e.,

```
Exponential(rate) = Gamma(concentration=1., rate)
```

The Exponential distribution uses a `rate` parameter, or "inverse scale", which can be intuited as,

```
X ~ Exponential(rate=1)
Y = X / rate
```

Properties

allow_nan_stats

Python `bool` describing behavior when a stat is undefined.

Stats return +/- infinity when it makes sense. E.g., the variance of a Cauchy distribution is infinity. However, sometimes the statistic is undefined, e.g., if a distribution's pdf does not achieve a maximum within the support of the distribution, the mode is undefined. If the mean is undefined, then by definition the variance is undefined. E.g. the mean for Student's T for $df = 1$ is undefined (no clear way to say it is either + or - infinity), so the variance = $E[(X - \text{mean})^2]$ is also undefined.

Returns:

- `allow_nan_stats`: Python `bool`.

batch_shape

Shape of a single sample from a single event index as a `TensorShape`.

May be partially defined or unknown.

The batch dimensions are indexes into independent, non-identical parameterizations of this distribution.

Returns:

- `batch_shape`: `TensorShape`, possibly unknown.

concentration

Concentration parameter.

dtype

The `DType` of `Tensor`s handled by this `Distribution`.

event_shape

Shape of a single sample from a single batch as a `TensorShape`.

May be partially defined or unknown.

Returns:

- `event_shape`: `TensorShape`, possibly unknown.

name

Name prepended to all ops created by this `Distribution`.

parameters

Dictionary of parameters used to instantiate this `Distribution`.

rate

reparameterization_type

Describes how samples from the distribution are reparameterized.

Currently this is one of the static instances `distributions.FULLY_REPARAMETERIZED` or `distributions.NOT_REPARAMETERIZED`.

Returns:

An instance of `ReparameterizationType`.

`validate_args`

Python `bool` indicating possibly expensive checks are enabled.

Methods

`__init__`

```
__init__(
    rate,
    validate_args=False,
    allow_nan_stats=True,
    name='Exponential'
)
```

Construct Exponential distribution with parameter `rate`.

Args:

- `rate`: Floating point tensor, equivalent to `1 / mean`. Must contain only positive values.
- `validate_args`: Python `bool`, default `False`. When `True` distribution parameters are checked for validity despite possibly degrading runtime performance. When `False` invalid inputs may silently render incorrect outputs.
- `allow_nan_stats`: Python `bool`, default `True`. When `True`, statistics (e.g., mean, mode, variance) use the value `"NaN"` to indicate the result is undefined. When `False`, an exception is raised if one or more of the statistic's batch members are undefined.
- `name`: Python `str` name prefixed to Ops created by this class.

`batch_shape_tensor`

```
batch_shape_tensor(name='batch_shape_tensor')
```

Shape of a single sample from a single event index as a 1-D `Tensor`.

The batch dimensions are indexes into independent, non-identical parameterizations of this distribution.

Args:

- `name`: name to give to the op

Returns:

- `batch_shape`: `Tensor`.

cdf

```
cdf(  
    value,  
    name='cdf'  
)
```

Cumulative distribution function.

Given random variable X , the cumulative distribution function **cdf** is:

```
cdf(x) := P[X <= x]
```

Args:

- **value**: **float** or **double Tensor**.
- **name**: The name to give this op.

Returns:

- **cdf**: a **Tensor** of shape **sample_shape(x) + self.batch_shape** with values of type **self.dtype**.

copy

```
copy(**override_parameters_kwargs)
```

Creates a deep copy of the distribution.

★ **Note:** the copy distribution may continue to depend on the original initialization arguments.

Args:

- ****override_parameters_kwargs**: String/value dictionary of initialization arguments to override with new values.

Returns:

- **distribution**: A new instance of **type(self)** initialized from the union of **self.parameters** and **override_parameters_kwargs**, i.e., **dict(self.parameters, **override_parameters_kwargs)**.

covariance

```
covariance(name='covariance')
```

Covariance.

Covariance is (possibly) defined only for non-scalar-event distributions.

For example, for a length-**k**, vector-valued distribution, it is calculated as,

```
Cov[i, j] = Covariance(X_i, X_j) = E[(X_i - E[X_i]) (X_j - E[X_j])]
```

where **Cov** is a (batch of) **k x k** matrix, $0 \leq (i, j) < k$, and **E** denotes expectation.

Alternatively, for non-vector, multivariate distributions (e.g., matrix-valued, Wishart), **Covariance** shall return a (batch of) matrices under some vectorization of the events, i.e.,

```
Cov[i, j] = Covariance(Vec(X)_i, Vec(X)_j) = [as above]
```

where **Cov** is a (batch of) $k' \times k'$ matrices, $0 \leq (i, j) < k' = \text{reduce_prod}(\text{event_shape})$, and **Vec** is some function mapping indices of this distribution's event dimensions to indices of a length- k' vector.

Args:

- **name** : The name to give this op.

Returns:

- **covariance** : Floating-point **Tensor** with shape $[B_1, \dots, B_n, k', k']$ where the first n dimensions are batch coordinates and $k' = \text{reduce_prod}(\text{self.event_shape})$.

entropy

```
entropy(name='entropy')
```

Shannon entropy in nats.

event_shape_tensor

```
event_shape_tensor(name='event_shape_tensor')
```

Shape of a single sample from a single batch as a 1-D int32 **Tensor**.

Args:

- **name** : name to give to the op

Returns:

- **event_shape** : **Tensor**.

is_scalar_batch

```
is_scalar_batch(name='is_scalar_batch')
```

Indicates that **batch_shape == []**.

Args:

- **name** : The name to give this op.

Returns:

- **is_scalar_batch** : **bool** scalar **Tensor**.

is_scalar_event

```
is_scalar_event(name='is_scalar_event')
```

Indicates that `event_shape == []`.

Args:

- `name`: The name to give this op.

Returns:

- `is_scalar_event`: `bool` scalar `Tensor`.

log_cdf

```
log_cdf(  
    value,  
    name='log_cdf'  
)
```

Log cumulative distribution function.

Given random variable `X`, the cumulative distribution function `cdf` is:

```
log_cdf(x) := Log[ P[X <= x] ]
```

Often, a numerical approximation can be used for `log_cdf(x)` that yields a more accurate answer than simply taking the logarithm of the `cdf` when `x << -1`.

Args:

- `value`: `float` or `double Tensor`.
- `name`: The name to give this op.

Returns:

- `logcdf`: a `Tensor` of shape `sample_shape(x) + self.batch_shape` with values of type `self.dtype`.

log_prob

```
log_prob(  
    value,  
    name='log_prob'  
)
```

Log probability density/mass function.

Args:

- `value`: `float` or `double Tensor`.
- `name`: The name to give this op.

Returns:

- `log_prob`: a `Tensor` of shape `sample_shape(x) + self.batch_shape` with values of type `self.dtype`.

log_survival_function

```
log_survival_function(  
    value,  
    name='log_survival_function'  
)
```

Log survival function.

Given random variable `X`, the survival function is defined:

```
log_survival_function(x) = Log[ P[X > x] ]  
                        = Log[ 1 - P[X <= x] ]  
                        = Log[ 1 - cdf(x) ]
```

Typically, different numerical approximations can be used for the log survival function, which are more accurate than `1 - cdf(x)` when `x >> 1`.

Args:

- `value`: `float` or `double Tensor`.
- `name`: The name to give this op.

Returns:

`Tensor` of shape `sample_shape(x) + self.batch_shape` with values of type `self.dtype`.

mean

```
mean(name='mean')
```

Mean.

mode

```
mode(name='mode')
```

Mode.

Additional documentation from `Gamma`:

The mode of a gamma distribution is `(shape - 1) / rate` when `shape > 1`, and `NaN` otherwise. If `self.allow_nan_stats` is `False`, an exception will be raised rather than returning `NaN`.

param_shapes

```
param_shapes(
    cls,
    sample_shape,
    name='DistributionParamShapes'
)
```

Shapes of parameters given the desired shape of a call to `sample()`.

This is a class method that describes what key/value arguments are required to instantiate the given `Distribution` so that a particular shape is returned for that instance's call to `sample()`.

Subclasses should override class method `_param_shapes`.

Args:

- `sample_shape`: `Tensor` or python list/tuple. Desired shape of a call to `sample()`.
- `name`: name to prepend ops with.

Returns:

`dict` of parameter name to `Tensor` shapes.

`param_static_shapes`

```
param_static_shapes(
    cls,
    sample_shape
)
```

`param_shapes` with static (i.e. `TensorShape`) shapes.

This is a class method that describes what key/value arguments are required to instantiate the given `Distribution` so that a particular shape is returned for that instance's call to `sample()`. Assumes that the sample's shape is known statically.

Subclasses should override class method `_param_shapes` to return constant-valued tensors when constant values are fed.

Args:

- `sample_shape`: `TensorShape` or python list/tuple. Desired shape of a call to `sample()`.

Returns:

`dict` of parameter name to `TensorShape`.

Raises:

- `ValueError`: if `sample_shape` is a `TensorShape` and is not fully defined.

`prob`


```
prob(
    value,
    name='prob'
)
```

Probability density/mass function.

Args:

- `value`: `float` or `double Tensor`.
- `name`: The name to give this op.

Returns:

- `prob`: a `Tensor` of shape `sample_shape(x) + self.batch_shape` with values of type `self.dtype`.

quantile

```
quantile(
    value,
    name='quantile'
)
```

Quantile function. Aka "inverse cdf" or "percent point function".

Given random variable `X` and `p in [0, 1]`, the `quantile` is:

```
quantile(p) := x such that P[X <= x] == p
```

Args:

- `value`: `float` or `double Tensor`.
- `name`: The name to give this op.

Returns:

- `quantile`: a `Tensor` of shape `sample_shape(x) + self.batch_shape` with values of type `self.dtype`.

sample

```
sample(
    sample_shape=(),
    seed=None,
    name='sample'
)
```

Generate samples of the specified shape.

Note that a call to `sample()` without arguments will generate a single sample.

Args:

- `sample_shape`: 0D or 1D `int32 Tensor`. Shape of the generated samples.

- `seed` : Python integer seed for RNG
- `name` : name to give to the op.

Returns:

- `samples` : a `Tensor` with prepended dimensions `sample_shape`.

stddev

```
stddev(name='stddev')
```

Standard deviation.

Standard deviation is defined as,

$$\text{stddev} = E[(X - E[X])**2]**0.5$$

where X is the random variable associated with this distribution, E denotes expectation, and `stddev.shape = batch_shape + event_shape`.

Args:

- `name` : The name to give this op.

Returns:

- `stddev` : Floating-point `Tensor` with shape identical to `batch_shape + event_shape`, i.e., the same shape as `self.mean()`.

survival_function

```
survival_function(
    value,
    name='survival_function'
)
```

Survival function.

Given random variable X , the survival function is defined:

$$\begin{aligned} \text{survival_function}(x) &= P[X > x] \\ &= 1 - P[X \leq x] \\ &= 1 - \text{cdf}(x). \end{aligned}$$

Args:

- `value` : `float` or `double Tensor`.
- `name` : The name to give this op.

Returns:

`Tensor` of shape `sample_shape(x) + self.batch_shape` with values of type `self.dtype`.

variance

```
variance(name='variance')
```

Variance.

Variance is defined as,

$$\text{Var} = E[(X - E[X])**2]$$

where **X** is the random variable associated with this distribution, **E** denotes expectation, and **Var.shape = batch_shape + event_shape**.

Args:

- **name**: The name to give this op.

Returns:

- **variance**: Floating-point **Tensor** with shape identical to **batch_shape + event_shape**, i.e., the same shape as **self.mean()**.

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