

tf.contrib.distributions.NegativeBinomial

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Class **NegativeBinomial**Inherits From: [Distribution](#)Defined in [tensorflow/contrib/distributions/python/ops/negative_binomial.py](#).

NegativeBinomial distribution.

The NegativeBinomial distribution is related to the experiment of performing Bernoulli trials in sequence. Given a Bernoulli trial with probability `p` of success, the NegativeBinomial distribution represents the distribution over the number of successes `s` that occur until we observe `f` failures.

The probability mass function (pmf) is,

```
pmf(s; f, p) = p**s (1 - p)**f / Z
Z = s! (f - 1)! / (s + f - 1)!
```

where: `total_count = f`, `probs = p`, `Z` is the normalizaing constant, and, `n!` is the factorial of `n`.

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.

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.

logits

Log-odds of a `1` outcome (vs `0`).

name

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

parameters

Dictionary of parameters used to instantiate this `Distribution`.

probs

Probability of a `1` outcome (vs `0`).

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`.

total_count

Number of negative trials.

validate_args

Python `bool` indicating possibly expensive checks are enabled.

Methods

`__init__`

```
__init__(
    total_count,
    logits=None,
    probs=None,
    validate_args=False,
    allow_nan_stats=True,
    name='NegativeBinomial'
)
```

Construct NegativeBinomial distributions.

Args:

- `total_count`: Non-negative floating-point `Tensor` with shape broadcastable to `[B1, ..., Bb]` with `b >= 0` and the same dtype as `probs` or `logits`. Defines this as a batch of `N1 x ... x Nm` different Negative Binomial distributions. In practice, this represents the number of negative Bernoulli trials to stop at (the `total_count` of failures), but this is still a valid distribution when `total_count` is a non-integer.
- `logits`: Floating-point `Tensor` with shape broadcastable to `[B1, ..., Bb]` where `b >= 0` indicates the number of batch dimensions. Each entry represents logits for the probability of success for independent Negative Binomial distributions and must be in the open interval `(-inf, inf)`. Only one of `logits` or `probs` should be specified.
- `probs`: Positive floating-point `Tensor` with shape broadcastable to `[B1, ..., Bb]` where `b >= 0` indicates the number of batch dimensions. Each entry represents the probability of success for independent Negative Binomial distributions and must be in the open interval `(0, 1)`. Only one of `logits` or `probs` should be specified.
- `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) $k \times k$ 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 $x \gg 1$.

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.

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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