# Tweedie

## **Parametrisation**

The Tweedie distribution<sup>1</sup> is a compond Poisson-Gamma model, where

$$Y = \sum_{i=1}^{N} X_i,$$

and  $\{X_i\}$  are iid Gamma variables with parameter  $(\alpha, \gamma)$  so that the mean of  $X_i$  is  $\alpha \gamma$  and variance  $\alpha \gamma^2$ , and N is (independent) Poisson with mean  $\lambda$ . Since N can be 0 with a positive probability, then the Tweedie distribution have a singleton in zero and is continuous for y > 0.

We will use the following reparametersation

$$\mu = \lambda \alpha \gamma, \qquad p = \frac{\alpha + 2}{\alpha + 1}, \qquad \frac{\phi}{w} = \frac{\lambda^{1-p} (\alpha \gamma)^{2-p}}{2-p}$$

where w > 0 is a fixed scaling, so the mean of Y is  $\mu > 0$ , variance is  $\frac{\phi}{w}\mu^p$  where  $1 , and <math>\phi$  is a dispersion parameter.

#### Link-function

The linkfunction is given as

$$\log(\mu) = \eta$$

where  $\eta$  is the linear predictor.

# **Hyperparameters**

The hyperparameters are  $\theta = (\theta_1, \theta_2)$ , where

$$p = 1 + \frac{\exp(\theta_1)}{1 + \exp(\theta_1)}, \quad 1$$

and

$$\phi = \exp(\theta_2), \qquad \phi > 0$$

The priors are given on  $(\theta_1, \theta_2)$ .

## Specification

- family="tweedie"
- Required arguments: y (and optional w through option scale)

### Hyperparameter spesification and default values

 $\operatorname{doc}$  Tweedie distribution

hyper

theta1

hyperid 102101 name p

<sup>&</sup>lt;sup>1</sup>This documentation follows the notation in Likelihood-based and Bayesian methods for Tweedie compound Poisson linear mixed models, by Yanwei Zhang, Stat Comput (2013) 23:743-757, DOI 10.1007/s11222-012-9343-7

```
short.name p
         output.name p parameter for Tweedie
         output.name.intern p_intern parameter for Tweedie
         initial 0
         fixed FALSE
         prior normal
         param 0 100
         to.theta function(x, interval = c(1.0, 2.0)) log(-(interval[1] - x) / (interval[2] - x)
         from.theta function(x, interval = c(1.0, 2.0)) interval[1] + (interval[2] - interval
     theta2
         hyperid 102201
         name dispersion
         short.name phi
         output.name Dispersion parameter for Tweedie
         output.name.intern Log dispersion parameter for Tweedie
         initial -4
         fixed FALSE
         prior loggamma
         param 100 100
         to.theta function(x) log(x)
         from.theta function(x) exp(x)
survival FALSE
discrete FALSE
link default log
pdf tweedie
Example
In the following example we estimate the parameters in a simulated example.
library(tweedie)
library(INLA)
n <- 300
x \leftarrow rnorm(n, sd = 0.2)
eta <- 1 + x
mu <- exp(eta)</pre>
p < -1.32
phi <- 2.0
y <- numeric(n)
for(i in 1:n) {
    y[i] <- rtweedie(1, xi = p, mu = mu[i], phi = phi)
r \leftarrow inla(y ~1 + x,
```

### Notes

This distribution is experimental, and changes will occur.