

# Tweedie

## Parametrisation

The Tweedie distribution<sup>1</sup> is a compound 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 reparametrisation

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

where  $w > 0$  is a fixed scaling, so the mean of  $Y$  is  $\mu > 0$ , variance is  $\frac{\phi}{w}\mu^p$  where  $1 < p < 2$ , and  $\phi$  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

$$p = 1 + \frac{\exp(\theta_1)}{1 + \exp(\theta_1)}, \quad 1 < p < 2.$$

and

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

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

**doc** Tweedie distribution

**hyper**

**thetal**

**hyperid** 102101

**name** p

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<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
    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] -
    from.theta function(x, interval = c(1.0, 2.0)) interval[1] + (interval[2] - interval[1]) * x)
  theta2
    hyperid 102201
    name dispersion
    short.name phi
    initial -4
    fixed FALSE
    prior loggamma
    param 100 100
    to.theta function(x) log(x)
    from.theta function(x) exp(x)

status experimental

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 <- rnorm(n, sd = 0.2)
eta <- 1 + x
mu <- exp(eta)

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 <- inla(y ~ 1 + x,
  data = data.frame(y, x),
  ## offset = rep(log(mean(y)), n),
  family = "tweedie",

```

```

control.family = list(hyper = list(
  theta1 = list(initial = 0),
  theta2 = list(initial = -4,
    prior = "loggamma",
    param = c(100, 100))),
## control.fixed = list(prec = 0, prec.intercept = 1),
## control.inla = list(cmin = 0, b.strategy = "skip"),
## inla.mode = "experimental",
num.threads = "4:1",
verbose = T)
summary(r)

```

## Notes

This distribution is experimental, and changes will occur.