Skew-Normal stochastic volatility likelihood

Parametrisation

The standardised Skew-Normal distribution is

$$f(z) = \frac{2}{\omega_\alpha} \phi\left(\frac{z - \xi_\alpha}{\omega_\alpha}\right) \Phi\left(\alpha \frac{z - \xi_\alpha}{\omega_\alpha}\right)$$

where ω_α and ξ_α are so that the mean is zero and variance is one, and they a functions of the skewness parameter α. The skewness s is the standardised skewness (standarized third central moment), which is a function of α

The skew-normal stochastic likelihood is defined as the density wrt y, where y is Skew-Normal distributed with zero mean, skewness s and variance

$$\text{variance} = \exp(\eta) + 1/\tau$$

and

η: is the the linear predictor

τ: is an offset in the variance

Link-function

The variance depends on the linear predictor

$$\mu = \exp(\eta) + 1/\tau$$

Hyperparameters

The (standardised) skewness s, is represented as

$$\gamma = 0.988(2\frac{\exp(\theta_1)}{1 + \exp(\theta_1)} - 1)$$

and the prior is defined on θ_1.

The offset in the variance, $1/\tau$ is represented as

$$\tau = \exp(\theta_2)$$

and the prior is defined on θ_2. (By default θ_2 is fixed to a high value which makes $1/\tau \approx 0$.)

Specification

- family = `stochvolsn`

- Required arguments: y.

Hyperparameter specification and default values

doc The SkewNormal stochvol likelihood

hyper

    theta1

        hyperid 82101

        name logit skew

        short.name skew

        initial 0.00123456789

        fixed FALSE

        prior pc.sn

        param 10

        to.theta `function(x, skew.max = 0.988) log((1 + x / skew.max) / (1 - x / skew.max))`

        from.theta `function(x, skew.max = 0.988) skew.max * (2 * exp(x) / (1 + exp(x)) - 1)`

    theta2

        hyperid 82102

        name log precision

        short.name prec

        initial 500

        fixed TRUE

        prior loggamma

        param 1 0.005

        to.theta `function(x) log(x)`

        from.theta `function(x) exp(x)`

status experimental

survival FALSE

discrete FALSE

link default log

pdf stochvolsn

Example

```
library(sn)
n <- 1000
x <- scale(arima.sim(n, model= list(ar = 0.95)))
skew <- 0.2
y <- numeric(n)
for(i in 1:n) {
    variance <- exp(x[i])
    par <- unlist(INLA:::inla.sn.reparam(moments = c(0, variance, skew)))
    y[i] <- rsn(1, dp = par)
}

r = inla(y ~ 1 + f(idx, model="ar1",
                hyper = list(
                    prec = list(prior = "pc.prec",
                                param = c(0.5, 0.01)),
                    rho = list(prior = "pc.cor1",
                                param = c(0.8, 0.5)))),
        control.fixed = list(prec.intercept = 1),
        data = data.frame(y, idx=1:n),
```

```
            family = "stochvolsn",
            control.inla = list(cmin = 0, b.strategy="skip"),
            num.threads = "3:1",
            verbose = TRUE)
summary(r)
```

Notes

This implementation is similar to `family="sn"`, see also that documentation.