Aggregated Gaussian

Parametrisation

This is shorthand to allow for aggregated Gaussian observations, where we have repeated observations with the same mean and (known scaled) precision. These can be aggregated into an equivalent likelihood reducing the computional effort.

Let $y = (y_1, \ldots, y_n)$ be iid observations of a Gaussian with mean μ and precisions $s_i\tau$, where the s_i's are fixed and known scaling parameters (default $s_i = 1$), then

$$\begin{aligned} f(y|\mu,\tau) &= \prod_{i=1}^{n}(2\pi)^{-1/2}(s_i\tau)^{1/2}\exp\left(-\frac{1}{2}(s_i\tau)\,(y_i-\mu)^2\right) && (1)\\ &= (2\pi)^{-n/2}\tau^{n/2}\left(\prod_{i=1}^{n}s_i^{1/2}\right)\exp\left(-\frac{1}{2}\tau\sum_{i=1}^{n}s_i(y_i-\mu)^2\right) && (2)\\ &= (2\pi)^{-n/2}\tau^{n/2}\left(\prod_{i=1}^{n}s_i^{1/2}\right)\exp\left(-\frac{1}{2}m\tau\left[(\bar{y}-\mu)^2+v\right]\right) && (3)\end{aligned}$$

where

$$\begin{aligned} m &= \sum_{i=1}^{n}s_i\\ \bar{y} &= \frac{1}{m}\sum_{i=1}^{n}s_iy_i\\ v &= \frac{1}{m}\sum_{i=1}^{n}s_iy_i^2-\bar{y}^2\end{aligned}$$

Link-function

The mean μ is linked to the linear predictor η by

$$\mu = \eta$$

Hyperparameters

The hyperparameter is θ, where

$$\theta = \log\tau$$

and the prior is defined on θ.

Specification

This family require the response to be an `inla.mdata`-object, where each row[1] is

$$(v,\ \frac{1}{2}\sum_{i=1}^{n}\log(s_i),\ m,\ n,\ \bar{y})$$

This object is most easily constructed using the `inla.agaussian()` function, which gives the object to use directly.

- `family="agaussian"`
- Required arguments: An `inla.mdata`-object created with `inla.agaussian()`.

[1] It is a list of vectors, so not strictly a "row".

Hyperparameter spesification and default values

doc `The aggregated Gaussian likelihoood`

hyper

- **theta**
  - **hyperid** `66001`
  - **name** `log precision`
  - **short.name** `prec`
  - **output.name** `Precision for the AggGaussian observations`
  - **output.name.intern** `Log precision for the AggGaussian observations`
  - **initial** `4`
  - **fixed** `FALSE`
  - **prior** `loggamma`
  - **param** `1 5e-05`
  - **to.theta** `function(x) log(x)`
  - **from.theta** `function(x) exp(x)`

survival `FALSE`

discrete `FALSE`

link `default identity logit loga cauchit log logoffset`

pdf `agaussian`

Example

```
## plain example, either with all n observations or to aggregate them
n <- 10
y <- rnorm(n)
Y <- inla.agaussian(y)

r <- inla(Y ~ 1,
          data = list(Y = Y),
          family = "agaussian")
rr <- inla(y ~ 1,
           data = data.frame(y),
           family = "gaussian")
print(r$mlik - rr$mlik)

inla.dev.new()
par(mfrow = c(1, 2))
plot(r$internal.marginals.hyperpar[[1]], pch = 19, main = "prec")
lines(rr$internal.marginals.hyperpar[[1]], lwd = 3)
plot(r$marginals.fixed$'(Intercept)', pch = 19, main = "intercept")
lines(rr$marginals.fixed$'(Intercept)', lwd = 3)

####################################
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```

```
## same example, but with different scalings for the precision for 'yy'
n <- 5
s <- 1:n ## scale the precision
y <- rnorm(n)
yy <- rnorm(n, sd = sqrt(1/s))
Y <- inla.agaussian(rbind(y, yy),
                    rbind(rep(1, n), s))

r <- inla(Y ~ 1,
          data = list(Y = Y),
          family = "agaussian",
          control.compute = list(cpo = TRUE, dic = TRUE))
rr <- inla(yyy ~ 1,
           data = data.frame(yyy = c(y, yy)),
           scale = c(rep(1, n), s),
           control.compute = list(cpo = TRUE, dic = TRUE),
           family = "gaussian")
print(r$mlik - rr$mlik)

inla.dev.new()
par(mfrow = c(1, 2))
plot(r$internal.marginals.hyperpar[[1]], pch = 19, main = "prec")
lines(rr$internal.marginals.hyperpar[[1]], lwd = 3)
plot(r$marginals.fixed$'(Intercept)', pch = 19, main = "intercept")
lines(rr$marginals.fixed$'(Intercept)', lwd = 3)


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## if one want to build the aggrated data for each replication
## at the time, one can do

y.agg <- unlist(inla.agaussian(y))
yy.agg <- unlist(inla.agaussian(yy, s))
agg.matrix <- rbind(y.agg, yy.agg)
Y.agg <- inla.mdata(agg.matrix)

## and then
r.agg <- inla(Y.agg ~ 1,
              data = list(Y.agg = Y.agg),
              family = "agaussian")

## For further details, see also INLA:::inla.agaussian.test()
```

Notes

- Thanks to JW for suggesting this formulation and for providing the details.