

Bayesian hierarchical models for NHPP using **rstan**

Miao Cai *miao.cai@slu.edu*

2019-06-26

Contents

1	Model setting	1
2	Simulating data	2

1 Model setting

Let $T_{d,s,i}$ denote the time to the d -th driver's s -th shift's i -th critical event. The total number critical events of d -th driver's s -th shift is $n_{d,s}$. The ranges of these notations are:

- $i = 1, 2, \dots, n_{d,S_d}$,
- $s = 1, 2, \dots, S_d$,
- $d = 1, 2, \dots, D$.

We assume the times of critical events within the d -th driver's s -th shift were generated from a non-homogeneous Poisson process (NHPP) with a power law process (PLP), with a fix rate parameter β and varying scale parameters $\theta_{d,s}$ across drivers. The data generating process is then:

$$T_{d,s,1}, T_{d,s,2}, \dots, T_{d,s,n_{d,s}} \sim \text{PLP}(\beta, \theta_{d,s})$$

$$\beta \sim \text{Gamma}(1, 1)$$

$$\log \theta_{d,s} = \gamma_{0d} + \gamma_1 x_{d,s,1} + \gamma_2 x_{d,s,2} + \dots + \gamma_k x_{d,s,k}$$

$$\gamma_{0i}, \gamma_{0i}, \dots, \gamma_{0D} \sim \text{i.i.d. } N(\mu_0, \sigma_0^2)$$

$$\gamma_1, \gamma_2, \dots, \gamma_k \sim \text{i.i.d. } N(0, 10^2)$$

$$\mu_0 \sim N(0, 10^2)$$

$$\sigma_0 \sim \text{Gamma}(1, 1)$$

2 Simulating data

```
set.seed(123)

D = 10 # the number of drivers
K = 3 # the number of predictor variables

# hyperparameters
mu0 = rnorm(1, mean = 0, sd = 10)
sigma0 = rgamma(1, 1, 1)

# Fixed-effects parameters
R = rnorm(K, mean = 0, sd = 10)

# Random intercepts
r0 = rnorm(D, mean = mu0, sd = sigma0)

# Generate  $x_1, x_2, \dots, x_K$ 
```