# Bayesian hierarchical models for NHPP using `rstan`

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*2019-06-20*

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## 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:

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

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 $\beta$ and varying scale parameters $\theta_{d,s}$ across drivers. The data generating process is then:

$$
\begin{aligned}
T_{d,s,1}, T_{d,s,2}, \cdots, T_{d,s,n_{d,s}} &\sim \text{PLP}(\beta, \theta_{d,s}) \\
\beta &\sim \text{Gamma}(1, 1) \\
\log \theta_{d,s} &= \gamma_{0d} + \gamma_1 x_{d,s,1} + \gamma_2 x_{d,s,2} + \cdots + \gamma_k x_{d,s,k} \\
\gamma_{0i}, \gamma_{0i}, \cdots, \gamma_{0D} &\sim \text{i.i.d. } N(\mu_0, \sigma_0^2) \\
\gamma_1, \gamma_2, \cdots, \gamma_k &\sim \text{i.i.d. } N(0, 10) \\
\mu_0 &\sim N(0, 10) \\
\sigma_0 &\sim \text{Gamma}(1, 1)
\end{aligned}
$$