- ***Slide 2 Pag.30***

The ***Relative Entropy*** (or Kullback-Leibler Distance) $D(f||g)$ between two densities $f(x)$ and $g(x)$ Is defined as:

$$D(f||g) = \int f(x,y)\, log_a \frac{f(x)}{g(x)} dx$$

$$\mathcal{D}(f||g) = \int f(x) \log_a \frac{f(x)}{g(x)} dx \qquad (1)$$

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The rate function λ for a Poisson process defines

$$\Pr(spike\ in\ [t, t+\Delta]) \approx \lambda\Delta$$

$$\Pr(k\ spikes\ in\ [t, t+s]) = \frac{(\lambda(s-t))^k}{k!} e^{-\lambda(s-t)} \qquad k=1,2,.....$$

$$Pr(k\ spikes\ in\ [t, t+s]) = \frac{(\lambda(s))^k}{k!} e^{-\lambda(s)} \qquad for\ k = 1, 2, \ldots \qquad (2)$$

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$$p(N_{0:T}) = \prod_{j=1}^{J} \lambda(u_j|H_u)\, e^{\left\{-\int_0^T \lambda(u|H_u)\, du\right\}}$$

$$p(N_{0:T}) = \prod_{j=1}^{J} \lambda(u_j|H_{u_j})e^{-\int_0^T \lambda(u|H_u)du} \tag{3}$$

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Fitting the GLM: Iterative least squares

Maximum Likelihood Estimation

$$max_\theta \log(\mathrm{p}(N_{0:T}, \theta)) = max_\theta \sum_{i=1}^{I} n_i log(\theta' x_i) - e^{\theta' x_i}$$

$$\underset{\theta}{\operatorname{argmax}} \mathcal{L}(\theta) = \underset{\theta}{\operatorname{argmax}} \sum_{i=1}^{I} \left(n_i(\theta' x_i) - e^{\theta' x_i} \right) \tag{4}$$

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Power Spectrum (N=2)

$$C(\omega_1) = \sum_{m=-\infty}^{+\infty} c_1(\tau_1)e^{-j\omega_1\tau_1}$$

Bispectrum (N=3)

$$C(\omega_1, \omega_2) = \sum_{m=-\infty}^{+\infty} \sum_{n=-\infty}^{+\infty} c_2(\tau_1, \tau_2)e^{-j\omega_1\tau_1}e^{-j\omega_2\tau_2}$$

Trispectrum (N=4)

$$C(\omega_1, \omega_2, \omega_3) = \sum_{m=-\infty}^{+\infty} \sum_{n=-\infty}^{+\infty} \sum_{n=-\infty}^{+\infty} c_3(\tau_1, \tau_2, \tau_3)e^{-j\omega_1\tau_1}e^{-j\omega_2\tau_2}e^{-j\omega_2\tau_3}$$

Power Spectrum:

$$C(\omega_1) = \sum_{\tau_1=-\infty}^{+\infty} c_2(\tau_1)e^{-j\omega_1\tau_1} \tag{5}$$

Bispectrum:

$$C(\omega_1,\omega_2)=\sum\nolimits_{\tau_1=-\infty}^{+\infty}\sum_{\tau_2=-\infty}^{+\infty}c_3(\tau_1,\tau_2)e^{-j\omega_1\tau_1}e^{-j\omega_2\tau_2} \tag{6}$$

Trispectrum:

$$C(\omega_1,\omega_2,\omega_3)=\sum\nolimits_{\tau_1=-\infty}^{+\infty}\sum_{\tau_2=-\infty}^{+\infty}\sum_{\tau_3=-\infty}^{+\infty}c_4(\tau_1,\tau_2,\tau_3)e^{-j\omega_1\tau_1}e^{-j\omega_2\tau_2}e^{-j\omega_3\tau_3} \tag{7}$$