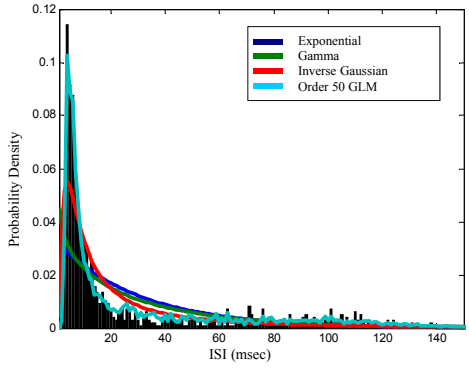
9.07 INTRODUCTION TO STATISTICS FOR BRAIN AND COGNITIVE SCIENCES
Emery N. Brown

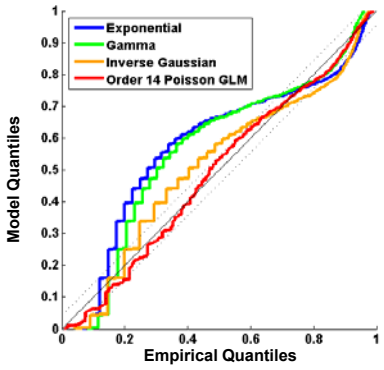
Lecture 3: Examples of Probability Models Applied to Data
Addendum

1. Gaussian Probability Model : Tetrode Recordings
2. Exponential Probability Model
   a. Channel Opening Times at the from NMJ
   b. Miniature Excitatory Post-Synaptic Currents
3. Gamma and Inverse Gaussian Probability Model: Interspike Interval Distributions
4. Beta Probability Model: Waking Up from General Anesthesia.

Interspike Interval Models



Kolmogorov-Smirnov Plots



Reanimation from General Anesthesia by Administering Ritalin

Animals are anesthetized with propofol.

Group 1: Saline Group
0 of 6 animals have return of righting

Group 2: Ritalin Group
11 of 12 animals have return of righting

Are animals more likely to have return of the righting reflex after Ritalin than after saline?

Probability Model: Binomial

Is p in one group different from p in the other group?

Group 1: Binomial (n = 6, k = 0)

p = 0/6 = 0

Group 2: Binomial (n = 12, k = 11)

p = 11/12 = 0.92

Chemali et al. Anesthesiology 2012

Bayes' Theory
What is the best estimate of p given the observed data?

$$f(p\,|\,k) = \frac{f(p)f(k\,|\,p)}{f(k)}$$

Probability Model for the Data

$$f(k_i|p_i) = \binom{n}{k_i} p_i^{k_i}(1-p_i)^{n-k}$$

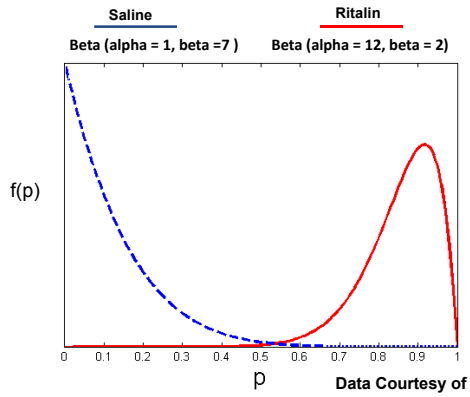
Prior Probability Model

$$f(p_i) = \frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)} p_i^{\alpha-1}(1-p_i)^{\beta-1},$$

Posterior Probability Model

$$f(p_i|k_i) = \frac{\Gamma(n+\alpha+\beta)}{\Gamma(k_i+\alpha)\Gamma(n-k_i+\beta)} \times p_i^{k_i+\alpha-1}(1-p_i)^{n-k_i+\beta-1}.$$

Two Beta Posterior Densities

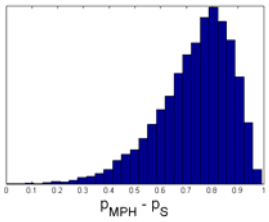


Chemali et al Anesthesiology 2012

Data Courtesy of Ken Solt
Analysis by Jessica Chemali

Probability Density of the Difference in the Probabilities

$f(p_{MPH} - p_S)$



$$\Pr(p_{MPH} > p_S) = \Pr(p_{MPH} - p_S > 0) > 0.95$$

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