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

Interspike Interval Models

Kolmogorov-Smirnov Plots
Reanimation from General Anesthesia by Administering Ritalin

Animals are anesthetized with propofol.

Group 1: Saline Group
Group 2: Ritalin Group
0 of 6 animals
11 of 12 animals have
have return of righting
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 ($n = 6$, $k = 0$) Group 2: Binomial ($n = 12$, $k = 11$)

$p = 0/6 = 0$

$p = 11/12 = 0.92$

Chemali et al. Anesthesiology 2012

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Bayes’ Theory

What is the best estimate of $p$ given the observed data?

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

Probability Model for the Data

$f(k|p) = \binom{k}{i} p^i (1-p)^{k-i}$

Prior Probability Model

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

Posterior Probability Model

$f(p|k) = \frac{\Gamma(n + \alpha + \beta)}{\Gamma(k + \alpha)\Gamma(n-k + \beta)} p^{\alpha+k-1}(1-p)^{n-k-\beta-1}$

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Two Beta Posterior Densities

Saline

Ritalin

Beta ($\alpha = 1$, $\beta = 7$)

Beta ($\alpha = 12$, $\beta = 2$)

Data Courtesy of Ken Solt

Analysis by Jessica Chemali

Chemali et al. Anesthesiology 2012
Probability Density of the Difference in the Probabilities

\[ f(p_{\text{MPH}} - p_{0}) \]

\[ \Pr(p_{\text{MPH}} > p_{0}) = \Pr(p_{\text{MPH}} - p_{0} > 0) > 0.95 \]