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Logistic Regression

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Topics

- Making the case for another type of regression
- Simple logistic regression (LR)
- Estimation/inference in logistic regression
- Prediction with LR
Section A

Logarithms: A Short Review
Let’s Review Logarithms

- **Strict definition of a logarithm**
  - The logarithm to the base \( a \) of a number \( y \) is the number \( x \) such that \( a^x = y \)
  - \( x = \log_a y \)

- We will be dealing with logs to base \( e \), where \( e \) is the natural constant
  - If \( x = \log_e y \), then \( y = e^x \) (anti-log of \( x \), exponentiating \( x \))
  - \( \log_e y \) frequently written \( \ln(y) \)
  - In this class \( \log \) and \( \ln \) both refer to logarithm with base \( e \)
Let’s Review Logarithms

- Logarithms only exist for positive numbers
  - $0 < y < \infty$

- However, logarithms can be positive or negative

- The following properties are true for all logarithms, regardless of base
  - $-\infty < \log(y) < \infty$
  - $\log (1) = 0$
  - If $0 < y < 1$, $\log(y) < 0$
  - If $y > 1$, $\log(y) > 0$
Let’s Review Logarithms

- Examples with logarithms of base \( e \) (the statistics literature will use both \( \ln \) and \( \log \) to refer to logarithms of base \( e \))
  - \( \log(10) = 2.3 \quad \rightarrow \quad e^{2.3} = 10 \)
  - \( e^{-0.2} = 0.81 \quad \rightarrow \quad \log(0.81) = -0.2 \)
  - \( \ln(1.5) = 0.41 \quad \rightarrow \quad e^{0.41} = 1.5 \)
Let’s Review Logarithms

- Two important calculator keys:
  - \( \ln \) key
  - \( e^x \) key
For any two positive numbers $A, B$

- $\ln(A*B) = \ln(A) + \ln(B)$
- $\ln(A/B) = \ln(A) - \ln(B)$
For practice, prove the following to yourselves at home!

- \( \ln(12) = \ln(36) - \ln(3) \)
  \[ = \ln(4) + \ln(3) \]
  \[ = \ln(120) - \ln(10) \]

- \( \ln(100) = \ln(20) + \ln(5) \)
  \[ = \ln(100,000) - \ln(1000) \]

- \( \ln(0.7) = \ln(7) - \ln(10) \)
  \[ = \ln(35) - \ln(50) \]