

1 Deviance

$$\begin{aligned} P(Y_i = y_i) &= \pi_i(1 - \pi_i)^{y_i-1} \\ &= \exp[y_i \times \ln\left(\frac{\mu_i - 1}{\mu_i}\right) - \ln(\mu_i - 1)] \end{aligned}$$

Hence

$$\begin{aligned} l(m; y) &= \sum_i^n [y_i \times \ln\left(\frac{m_i - 1}{m_i}\right) - \ln(m_i - 1)] \\ D &= 2\phi[l(y; y) - l(\mu; y)] \\ D &= 2 \left(\sum_i^n \left[y_i \times \ln\left(\frac{y_i - 1}{y_i}\right) - \ln(y_i - 1) \right] - \sum_i^n \left[y_i \times \ln\left(\frac{\mu_i - 1}{\mu_i}\right) - \ln(\mu_i - 1) \right] \right) \\ D &= 2 \left(\sum_i^n \left[y_i \times \ln\left(\frac{y_i - 1}{y_i}\right) - \ln(y_i - 1) - y_i \times \ln\left(\frac{\mu_i - 1}{\mu_i}\right) + \ln(\mu_i - 1) \right] \right) \\ D &= 2 \left(\sum_i^n \left[y_i \times \ln\left(\frac{y_i - 1}{y_i} \times \frac{\mu_i}{\mu_i - 1}\right) + \ln\left(\frac{\mu_i - 1}{y_i - 1}\right) \right] \right) \end{aligned}$$