

$$l(\vec{p}) = \sum_i y_i \log p_i$$

$$\hat{p}_i = \frac{y_i}{n}$$

$$l(\vec{p}) = \sum_{i=1}^{k-1} y_i \log p_i + y_k \log \left(1 - \sum_{i=1}^k p_i\right)$$

$$\frac{\partial l(\vec{p})}{\partial p_i} = y_i \frac{1}{p_i} + y_k \frac{-1}{1 - \sum_{i=1}^{k-1} p_i} = \frac{y_i}{p_i} - \frac{y_k}{p_k}$$

$$\frac{y_i}{p_i} = \frac{y_R}{p_R} \Rightarrow$$

$$\hat{p}_i = \frac{y_i}{y_T} = \frac{y_i}{h}$$

$$p_i = y_i \cdot \frac{p_R}{y_R}$$

$$1 = \sum_i p_i = y_T \frac{p_R}{y_R}$$

$$p_R = y_R / y_T$$

$$2 \left[\ell(\vec{p}_1) - \ell(\vec{p}_0) \right]$$

$$= 2 \left[\sum_i y_i \log\left(\frac{y_i}{n}\right) - \sum_i y_i \log \hat{p}_i \right]$$

$$= 2 \sum_i y_i \log\left(\frac{y_i}{n \hat{p}_i}\right)$$