

$$\pi(p | \text{data}) \propto_p \pi(\text{data} | p) \pi(p)$$

$$= \prod_{i=1}^n \text{Binomial}(y_i; N, p) \cdot f(p)$$

$$= \prod_{i=1}^n \text{Binomial}(y_i; N, p) \text{Beta}(p; 1, 1) f(p)$$

$$\propto_p \text{Beta}(p; 1 + \sum_{i=1}^n y_i, 1 + nN - \sum_{i=1}^n y_i) f(p)$$