

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

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

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

$$\propto_p \text{Beta}(p; 1+S, 1+nN-S) f(p)$$