$$X_i \overset{iid}{\sim} \text{Binomial}(\underset{\text{known}}{n}, \underset{\text{unknown}}{p})$$

$$f(x_i) = \binom{n}{x_i} p^{x_i} (1-p)^{n-x_i}$$

$$f(x_1, x_2, \ldots, x_m) = \prod_{i=1}^{m} \binom{n}{x_i} p^{x_i} (1-p)^{n-x_i}$$

where I went wrong in class

$$= \left(\prod_{i=1}^{m} \binom{n}{x_i}\right) p^{\sum_{i=1}^{m} x_i} (1-p)^{nm - \sum_{i=1}^{m} x_i}$$

$$\ell(x_1, x_2, \ldots, x_m) = \sum_{i=1}^{m} \ln\binom{n}{x_i} + \ln p \cdot \sum_{i=1}^{m} x_i + \left(nm - \sum_{i=1}^{m} x_i\right) \cdot \ln(1-p)$$

$$= \sum_{i=1}^{m} \ln\binom{n}{x_i} + \ln p \cdot m\bar{x}_m + (nm - m\bar{x}) \ln(1-p)$$

$$\frac{\partial \ell}{\partial p} = \frac{m\bar{x}_m}{p} - \frac{nm - m\bar{x}}{1-p} = 0$$

$$(1-p)\cancel{m}\bar{x}_m = p(n\cancel{m} - \cancel{m}\bar{x})$$

$$\bar{x}_m - \cancel{p\bar{x}_m} = pn - \cancel{p\bar{x}_m}$$

$$\hat{p} = \frac{\bar{x}_m}{n} \quad \square$$

so we basically end up in the same place but we're averaging over the m observations