

- Combining the last two equations:

$$\begin{aligned} E(c^*(\alpha) | c(\alpha) = r) &= \sum_{i=1}^s N p_i \frac{p(c(\alpha_i) = r)}{\sum_{j=1}^s p(c(\alpha_j) = r)} \\ &= \frac{\sum_{i=1}^s N p_i p(c(\alpha_i) = r)}{\sum_{j=1}^s p(c(\alpha_j) = r)} \end{aligned}$$

- We will now transform this equation to derive Good-Turing smoothing