$N$ cups, $M$ balls. Denote $p_k$ as the probability that exactly $k$ cups are non-empty. Let $X$ be the number of non-empty cups. Then we have

$$E[X] = \sum_{k=1}^{M} kp_k$$

Finding $p_k$

Choose $k$ cups, $\binom{N}{k}$ possibilities. Then choose a partition of the $M$ balls into $k$ non-empty subsets. This is a Stirling number of the second kind, $\left\{\begin{array}{c} M \\ k \end{array}\right\}$ possibilities. Now arrange the partition in some order, $k!$ possibilities. The total number of possibilities for $M$ balls into $N$ cups is $N^M$. So this probability is

$$p_k = \frac{\binom{N}{k} \left\{\begin{array}{c} M \\ k \end{array}\right\} k!}{N^M}$$

Answer

$$E[X] = \sum_{k=1}^{M} \binom{N}{k} \left\{\begin{array}{c} M \\ k \end{array}\right\} k! \frac{k!}{N^M}$$

For instance, for $N = 5$ cups and $M = 4$ balls, we have $E[X] = \frac{369}{125} \approx 2.95$. Check it out on Wolfram Alpha

---

1 Check wikipedia. The formula is

$$\left\{\begin{array}{c} n \\ k \end{array}\right\} = \frac{1}{k!} \sum_{j=0}^{k} (-1)^{k-j} \left(\begin{array}{c} k \\ j \end{array}\right) j^n$$