$N$ 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

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

## 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[1], $\left\{ {M \atop k} \right\}$ 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

$$p_k = \frac{\binom{N}{k} \left\{ {M \atop k} \right\} k!}{N^M}$$

## Answer

$$E[X] = \sum_{k=1}^{M} \binom{N}{k} \left\{ {M \atop k} \right\} \frac{k \cdot k!}{N^M}$$

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 $\left\{ {n \atop k} \right\} = \frac{1}{k!} \sum_{j=0}^{k} (-1)^{k-j} \binom{k}{j} j^n$