Coin analogy

**Question:** If you toss a fair coin 10 times, what is the probability that you will get 10 heads?

**Answer:** $\approx 0.1\%$

**Question:** If you toss 1000 fair coins 10 times each, what is the probability that some coin will get 10 heads?

**Answer:** $\approx 63\%$
From coins to learning

BINGO?
A simple solution

\[
\Pr\left[ |E_{in}(g) - E_{out}(g)| > \epsilon \right] \leq \Pr\left[ |E_{in}(h_1) - E_{out}(h_1)| > \epsilon \right]
\]
\[
\text{or } |E_{in}(h_2) - E_{out}(h_2)| > \epsilon
\]
\[
\ldots
\]
\[
\text{or } |E_{in}(h_M) - E_{out}(h_M)| > \epsilon
\]
\[
\leq \sum_{m=1}^{M} \Pr\left[ |E_{in}(h_m) - E_{out}(h_m)| > \epsilon \right]
\]
The final verdict

\[ \mathbb{P}[|E_{\text{in}}(g) - E_{\text{out}}(g)| > \epsilon] \leq \sum_{m=1}^{M} \mathbb{P}[|E_{\text{in}}(h_m) - E_{\text{out}}(h_m)| > \epsilon] \leq \sum_{m=1}^{M} 2e^{-2\epsilon^2 N} \]

\[ \mathbb{P}[|E_{\text{in}}(g) - E_{\text{out}}(g)| > \epsilon] \leq 2Me^{-2\epsilon^2 N} \]