# Exponential Tail Bounds: Exercises

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**Confidence Bounds** A coin with bias $p = 0.6$ is flipped $t = 1000$ times, and we are interested in estimating the probability that more than $q = 0.7$ of the coin flips come up heads.

Find a bound on this probability by using

1. Markov's inequality;
2. Chebyshev's inequality;
3. the Chernoff bound.

Compare these results to each other, and to actual probability (about $2 \times 10^{-11}$).

**Geometric variable** Recall that a geometric random variable counts the number of coin flips you have to wait for the first success. When the coin is fair, the mean of this variable is 2, and its moment-generating function is

$$G(r) \;=\; \frac{e^r}{2 - e^r}, \qquad (r < \ln 2).$$

Suppose now that you add up $t = 100$ samples from such a geometric distribution. Bound the probability that this sum exceeds 250.