

## STEP II, 2002, Q12

- 12 On  $K$  consecutive days each of  $L$  identical coins is thrown  $M$  times. For each coin, the probability of throwing a head in any one throw is  $p$  (where  $0 < p < 1$ ). Show that the probability that on exactly  $k$  of these days more than  $l$  of the coins will each produce fewer than  $m$  heads can be approximated by

$$\binom{K}{k} q^k (1 - q)^{K-k},$$

where

$$q = \Phi\left(\frac{2h - 2l - 1}{2\sqrt{h}}\right), \quad h = L\Phi\left(\frac{2m - 1 - 2Mp}{2\sqrt{Mp(1-p)}}\right)$$

and  $\Phi(\cdot)$  is the cumulative distribution function of a standard normal variate.

Would you expect this approximation to be accurate in the case  $K = 7$ ,  $k = 2$ ,  $L = 500$ ,  $l = 4$ ,  $M = 100$ ,  $m = 48$  and  $p = 0.6$ ?



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