In their book *Thermal Physics*, Kittel and Kromer broached the question about the role of pure randomness in their homework question entitled ‘The meaning of “never” (page xx in the 2nd edition). The beginning of the problem reads

<It has been said (footnote: J. Jeans, Mysterious Universe, Cambridge University Press, 1930, p. 4. The statement is attributed to Huxley) that “six monkeys”, set to strum unintelligently on typewriters for millions of years, would be bound in time to write all the books in the British Museum.”…Could all the monkeys in the world have typed out a single specified book in the age of the universe?>

While the attribution to Huxley (presumably Thomas Henry Huxley) seems to be apocryphal, there is no denying that a large segment of the population shares in the expressed sentiment. But the operative question is should they believe in the power of random fluctuations and chance.

To help in answering the posed question, Kittel and Kromer ask the student to make the following assumptions:

* 44 keys on a typewriter - ignoring the use of the shift key, the breakdown is 26 letters, 10 digits, 8 punctuation marks. Modern laptop keyboards seem to have something more like 10 punctuation mark keys but a smaller number of keys is better for the meandering paws of the monkeys
* $$10^{10}$$ monkeys, which corresponds to 10 billion monkeys, which is roughly 30% more than the number of people walking the planet at this moment
* $$10^{18}$$ seconds are given the monkeys for their unorchestrated typing. This time span totals up at about 31.7 billion years compared to the 13.8 billion years [estimated age of the universe](https://en.wikipedia.org/wiki/Age_of_the_universe).
* Each monkey can type 10 characters per second, which fast even for the most trained typist.
* Specified text of Hamlet has $$10^5$$ characters and the text is to be regarded as case-insensitive.

Kittel and Kromer calculate that the probability that any 100,000 character string chosen at random matches Hamlet is $$10^{-164345}$$ and that the probability that the monkeys will produce Hamlet is $$10^{-164316}$$ to which they state:

<The probability of Hamlet is therefore zero in any operational sense of an event, so the original statement at the beginning of the problem is nonsense: one book, much less a library, will never occur in the total literary production of the monkeys.>

Numbers like these are, or should be, damning evidence to anyone who thinks structure arises solely from random fluctuations and has been a major hurdle that biologists have to deal with when considering how life evolves.

But, before moving onto an interesting take on randomness, it is useful to skim through the probability computations in a simplified setting. The question we will ask is what is the probability of producing the inviting string ‘hello’ given a keyboard with only 14 keys corresponding to the first fourteen letters of the alphabet {a,b,c,d,e,f,g,h,i,k,l,m,n,o}. There are five characters in the target string translating to five slots each with 14 possible choices for a grand total of 537,824 possible choices (one of which is shown below).

The only additional pieces used in the Kittel and Kromer problem is the use of logarithms to estimate the number of realizations of Hamlet at $$44^{10^5}$$ and the multiplication by $$10^29$$ for the number of realizations by the monkey population can produce in the allotted time.