(Investigating what happens to the ratio x/n as $n \to \infty$ leads to "the law of large numbers", a standard statistical technique.)

E.g. In 'bridge', a 'hand' is the receipt of 13 cards, so

$$p(\text{no aces in hand}) = \frac{\binom{48}{13}}{\binom{52}{13}} \cong 0.304$$

Assuming perfect shuffling each time, repeat 5 times, then

$$p\left(\begin{array}{c}\text{no aces in } x\\ \text{of 5 'hands'}\end{array}\right) = \binom{5}{x}(0.304)^x(0.696)^{5-x}.$$

If n is large, using Stirling's formula to approximate $r!$ can help the computation.

This can all be generalised to a multinomial distribution in an obvious way ...

Assume a Bernoulli experiment with $A_1, \dots, A_r$ as all possible events (exhaustive and exclusive) with probabilities $p_1, \dots, p_r$.

Now repeat the experiment n times, then

$$S = \{(x_1, \dots, x_r) \mid \Sigma x_i = n\}$$

is the sample space, and we define X on S by $X(a_1, \dots, a_r) := (a_1, \dots, a_r)$. Then

$$p(X = (x_1, \dots, x_r)) = \binom{n}{x_1 \dots x_r} p_1^{x_1} \cdots p_r^{x_r}.$$

Again we have

$$F(n) = \Sigma f(x_1, \dots, x_r)$$
$$= (p_1 + \dots + p_r)^n = 1$$

hence the moniker "multinomial" (again there are really only $(r-1)$ variables involved).