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The Usage of the Golden Theorem of Bernoulli in Agricultural Sfere

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Annotation: *In this article shown the important role of the subject "The theory of probability and mathematic statistics" in solving problems of agricultural sphere.*

Key words: *event, experiment, the formula of Bernoulli, integer, probability.*

Introduction

Many of the events that take place in the environment around us, and especially in agriculture, are of a random nature. If we encounter an event, we cannot say for sure that we will encounter it again. However, if this phenomenon is observed several times under constant conditions, it will be possible to express the occurrence of this phenomenon using formulas. For example, when a seed is planted, we cannot say that it will germinate. But if this experiment is examined in several seeds, some regularity can be observed. When seeds are sown, the ratio of germinated seeds to the total number of seeds differs little enough from any fixed number as their number increases. Such experiments are called voluntary test sequence schemes or Bernoulli schemes.

Jacob Bernoulli devoted several decades to the study of this problem, raising the question of the possibility of determining the theoretical probability based on the results of experiments. For example, it has been mathematically proven that the number "3" drops close to 1/6 when the game is thrown many times. He called this discovery the "golden theorem," and is now known as the law of large numbers [1, p. 283].

Jacob Bernoulli formulated his named theorem, and the Bernoulli theorem is one of the golden theorems in probability theory. This theorem was first published in Jacob Bernoulli's The Art of Suggestions. Let's take a closer look at its content. Let us conduct the Bernoulli n trials, i.e., these n trials are arbitrary, and the probability of occurrence of event A does not change from that trial to that trial.

Let us denote by p the probability that event A will occur in a single test, and that by $q = 1 - p$ the event inverse to event A will occur in that test. In this case, the probability that event A will occur exactly n times in n trials is expressed by the Bernoulli formula [2, p. 37]:

$$P_{m_1 m}(A) = C_n^m P^m \cdot q^{n-m} \qquad (1)$$

In practice, we often encounter issues that can be expressed in the form of repetitive trials. As a result of each test, event A may or may not occur. We are not interested in the result of each trial, but in the total number of events that occur as a result of a certain number of trials.

Modern scientists are trying to prove that the Bernoulli formula does not conform to the laws of nature and that problems can be solved without applying this formula. Of course, most problems of probability theory can be calculated even without Bernoulli's formula, the main thing is not to get lost in the sheer volume of numbers and data. For example, in order to protect agricultural products from hail and heavy rains, according to the hydrometeorological services, shots are fired at a group of dangerous clouds. Shots are fired from a single weapon with the possibility of hitting the same target. In this case, the number of most likely hits to the target is of interest. This is related to productivity and public safety, which we are interested in. Such issues are considered easy enough to solve when trials are free.

Issue 1:

Fifteen seeds were sown in the experimental field, their germination is uniform and equal to 80%. The following elementary events can occur:

A_0 – the number of germinated seeds is equal to 0;

A_1 - the number of germinated seeds is equal to 1;

A_2 - the number of germinated seeds is equal to 2;

and so on,

A_{15} – All seeds are forgetful.

How do you find the probability of the above events, in particular the probability of germination of 12 out of 15 seeds sown?

Solution:

The number of sown seeds is equal to the number of free trials, i.e. n = 15, and the number of germinated seeds is m = 12, p = 0.8, q = 1-0.8 = 0.2. In that case

$$P_{12,15} = \frac{15!}{12!3!} \cdot 0{,}8^{12} \cdot 0{,}2^3 = \frac{13 \cdot 14 \cdot 15}{2 \cdot 3} \cdot 0{,}8^{12} \cdot 0{,}2^3 \approx 0{,}2551.$$

There is a small probability that 15 to 12 seeding events will occur.

Issue 2:

In February, 10 cows should calve and each should have one fetus. The probability of each cow giving birth to a bull is constant, which is conditionally equal to 0.5. Consider the following set of elementary events:

A_0 - the number of born bulls is equal to 0, the number of heifers is 10;

A_1 - the number of born bulls is equal to 1, the number of heifers is equal to 9;

And so on,

A_{10} - the number of born bulls is equal to 10, the number of heifers is equal to 0.

Let us be asked, for example, to find the probability of giving birth to 7 novvos, 3 heifers.

Solution:

In that case n= 10, m= 7, p=0,5, q= 0,5.

$$P_{7,10} = \frac{10!}{7!3!} \cdot 0{,}5^7 \cdot 0{,}5^3 = \frac{8 \cdot 9 \cdot 10}{2 \cdot 3} \cdot 0{,}5^{10} \approx 0{,}12.$$

In conclusion, the Bernoulli formula allows us to calculate the exact value of the probability of occurrence of event A m times in n free trials determined by the Bernoulli scheme.

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