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SOME CONCEPTS FROM PROBABILITY AND STATISTICS AND OPPORTUNITIES TO INTEGRATE THEM IN TEACHING NATURAL SCIENCES

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Abstract. The aim of the suggested approach is to focus on acquisition of elements of Probability and Statistics that are included in the curricula of Mathematics, Informatics and Information Technologies in Bulgaria. The educational tools offered show the opportunities for co-related education in Informatics and Statistics. The approach used for the development of educational materials allows a quick and flexible reaction to the changes in education.

Keywords: teaching Probability and Statistics in Bulgaria; simulation modules; educational tools

Introduction

The integration of IT in education leads to reconsideration and improvement of the educational activities and their efficiency. In recent years, the integration of IT in teaching Probability and Statistics at the different educational levels has become significant. The use of interactive and visual presentations when teaching statistical concepts are summarized in (Veleva, 2015). Considerable development in the field of interactive multimedia educational software, directed at teaching Probability and Statistics, is observed on a worldwide scale.

Since 1999 several interactive software tools based on the VBA and MS Excel for teaching Statistics and Probability have been developed at the South West University of Blagoevgrad (Karashtranova, 2005; 2009).

Necessity of interactive teaching of probability and statistics

The reason to conduct research in this area is related to the ongoing changes in curricula in Mathematics, Informatics and Information Technologies. According to Ordinance N° 7 of 11.08.16 concerning profiled teaching, some of the specific teaching objectives include (Naredba No. 7/11.08.2016; Nadedba No. 7/11.08.2016; Naredba No. 4/30.11.2015; Naredba No. 5/30.11.2015):

Concerning Mathematics: (1) to form an idea of probabilistic models, as well as to form skills to apply such models and skills to estimate probability, based on combinatory considerations or on knowledge derived from observations and experiments; (2) to build up knowledge about the distribution of random variables as well as skills for their usage as a model of real situations; (3) To develop skills to use appropriate software to solve problems related to the studied subject.

Concerning Informatics: (4) to develop pupils' intellectual abilities to analyze information problems and to model solutions using an object-based approach; (5) to lay emphasis on the development of logical thinking, on the creativity in finding software solutions, coupled with maximum use of available program libraries, and the development of the necessary conditions for acquiring skills and competences for self-learning; (6) to identify the main trends of the application of Informatics as an interdisciplinary science in the contemporary dynamic and globally connected society in order to help students in their choice of professional realization or of a specialty in an institution of higher education.

Concerning Information Technologies: (7) to provide basic training for the students that they can use in order to continue their studies at a university and specialize in IT and/or to ensure their successful professional realization in the software business sector; (8) to provide the students with the opportunity to gain confidence in the application of IT in a variety of situations related to particular subject matter, scientific research, modern society and specific organizations; (9) to provide teaching aimed primarily at acquiring practical knowledge and skills in view of the effective implementation of appropriate IT in solving complex and topical tasks related to contemporary society practices.

Due to the changes in the curricula and the planned aims, certain problems form the daily school experience can be solved with the approach suggested here. Some of the problems are that teachers find difficulties mostly because of the lack of sufficient instructional materials. Also, certain foreign language difficulties in using state-of-the-art learning materials from the Internet prevent good teaching of the subject matter in Bulgarian (the mother tongue of teachers and students). The structure of the proposed learning and teaching materials does not always conform to the content included in the Bulgarian syllabi in Probability and Statistics in the Bulgarian Secondary Schools.

Main connections between the concepts

The existence of real connections between certain concepts from the Theory of Probability and Statistics and Informatics and Information Technologies can be the basis of developing teaching materials aiming at increasing the effectiveness when acquiring them and, respectively, achieving the objectives listed above. The very essence of such connections can be seen in Fig. 1.

Interactive simulation module

The article presents a teaching interactive simulation module based on the following real connections, some of which are shown in Fig. 1:

Combinatorics – Probability
Computer Simulation – Empirical Distribution
Computer Simulation – Theoretical Distribution

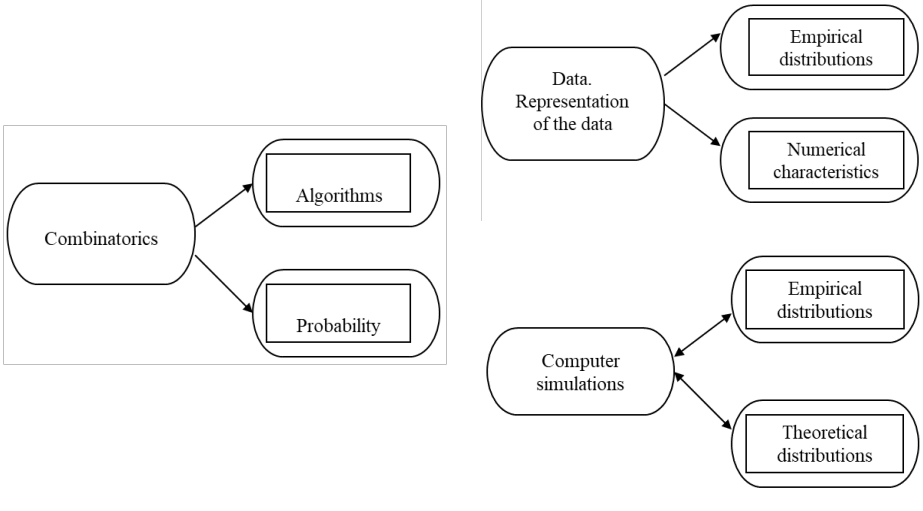

Figure 1. Schematic representation of the main connections between the concepts

On the basis of the following problem from the Theory of Probability the connections listed here are put into practice.

How many people should we ask for their birth day, so that the probability to have at least two of them born on the same week day, is 0.5.

Practically the module is realized through on opposite problem, which is intuitive and easy to understand.

How many people should we ask for their birth day, so that the probability to have all of them born on a different week day, is 1 – 0.5 = 0.5.

Example 1: k – parameter values; n – number of objects

This is a programme screen that illustrates which concepts the learners can use. They can put the parameters, simulate uniform distribution with these parameters and see all possible outcomes. The programme gives automatically the number of the variants without repetition. At the same time, in the down left corner the respective theoretical probabilities are calculated and, in this case the learner can make an empirical investigation and make a decision based on the simulation investigation and the theoretical backgrounds.

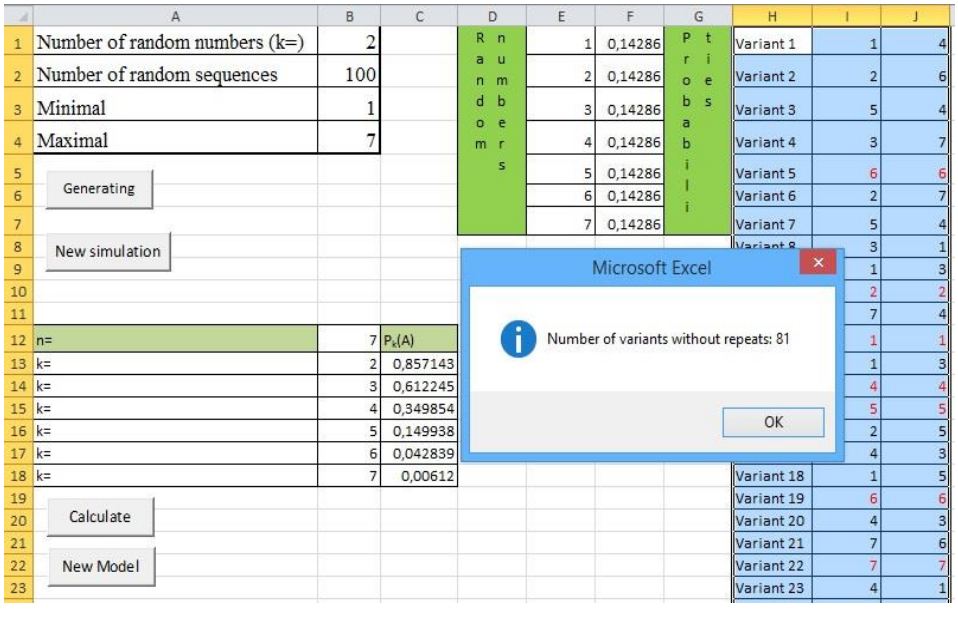

Figure 2. Product screen of example 1

Other examples 2 – 4

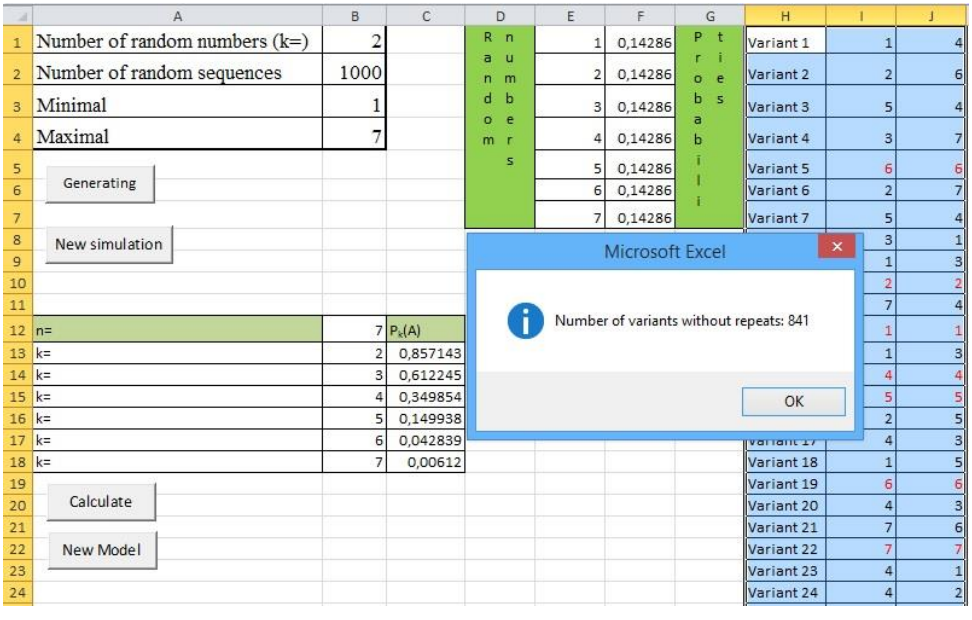

Figure 3. Product screen of example 2

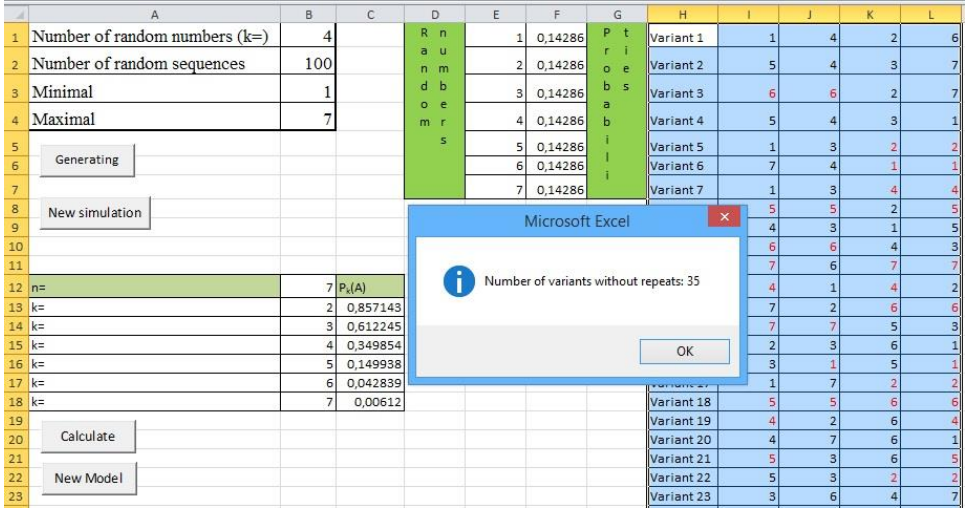

Figure 4. Product screen of example 3

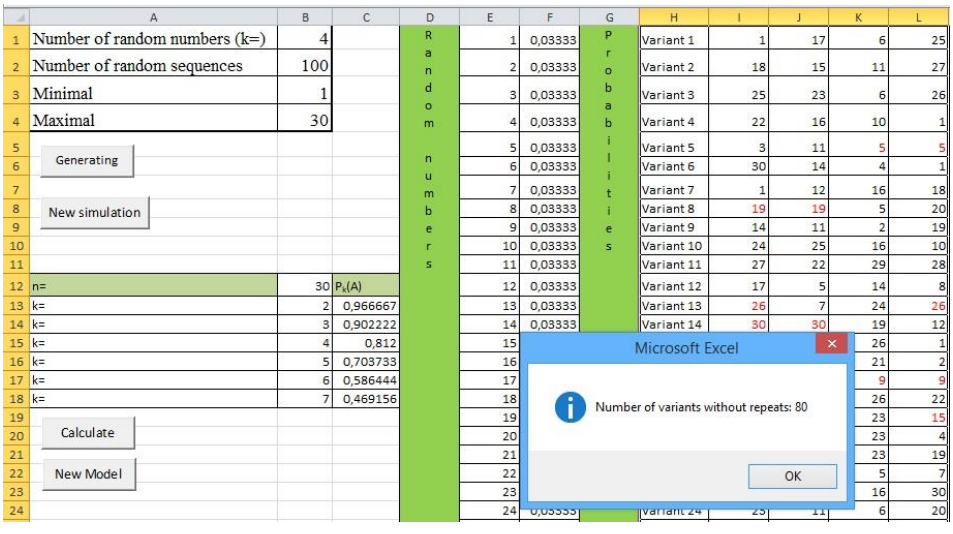

Figure 5. Product screen of example 4

The second screen clearly shows that when increasing the number of random sequences the approximation of the empirical results is closer to the theoretical value. In example 3 only the parameter K=4, i.e., the connections are visible.

How many people should we ask for their birth date, so that the probability to have at least two of them born on the same date of the month (1 – 31), is 0.5.

This task can be easily multiplied for different real models. In this way, the following concepts from the Theory of Probability and Information technology can be acquired: Classical Probability, Simulations, Uniform Distribution, Random Number of Generators.

Conclusions

As it can be seen from the data presented above, the content of the Bulgarian school course in Probability and Statistics has been significantly increased in terms of both volume and complexity. This fact requires the development and implementation of additional teaching materials, aids and approaches involving stochastic concepts and ideas, as well as, providing additional training for the teachers. As a matter of fact, all these concepts (empirical distributions, theoretical distributions, random number generators and computer simulation) are widely used and applied in all Natural and Social Sciences, as well.

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