Probability Theory and Mathematical Statistics E-course in Nomotex DLS

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Abstract. The paper considers the concept of constructing Probability Theory and Mathematical Statistics electronic course for interactive learning. The approach to the design of the e-course is described, and the advantages of using the new teaching technology in the Digital Learning System Nomotex, developed at the Department of Computational Mathematics and Mathematical Physics of the Bauman Moscow State Technical University, are demonstrated.

1 Introduction

The Digital Learning System (DLS) Nomotex, created at the Department of Computational Mathematics and Mathematical Physics of Bauman Moscow State Technical University, is an original development of the Department and is designed to implement a model of digital-classroom learning. The innovative principles and techniques underlying this model are described in detail in the works [1-4].

This work describes probability theory and mathematical statistics course development in the DLS Nomotex framework and analyses its features.

2 The design of Probability Theory and Mathematical Statistics course in the DLS Nomotex environment

Due to the widespread demand in the digital age for skills and abilities to work with large amounts of information (big data), Probability Theory and Mathematical Statistics (PTMS) e-courses [5], [6] are an integral part of the curricula of the vast majority of specialties and training areas for engineers, economists, biologists, and financiers (see http://fgosvo.ru). An important feature of probabilistic disciplines conducted both at the department represented by the authors and at the University as a whole is their wide variety in the range from short two-credits introductory courses to a two-semester sequential detailed and advanced course that implies the acquisition of programming skills for statistical modelling. In recent decades, all leading universities, including BMSTU, have been actively working to modernize their courses [7-13].

Nowadays, it is particularly important to construct a course according to the scope and required set of student’s competencies [14-19]. The DLS Nomotex platform provides a

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convenient way to design a course. At this stage, the amount of entered material (see figure 1, 2) allows one to create Probability Theory and Mathematical Statistics e-courses in the range from two to five credit points.

![Diagram of course structure](image)

**Fig. 1.** Structure of the PTMS e-course in the DLS Nomotex: division into chapters.

![Diagram of chapter structure](image)

**Fig. 2.** Structure of Chapter 4 of PTMS e-course: division into paragraphs.

### 3 An example of interactive-mode learning for the Gaussian model

Let us consider the advantages of the implemented interactive learning format using as an example the study of a two-dimensional Gaussian model in the DLS Nomotex. The stated topic is the content of the section "Gaussian random vector and its properties", which consists of six elements (quanta) with links to other elements of the course and the ability to use reference information (for example, table values of the Laplace function).

After presenting theoretical information in the form of a lecture with either full, partial or no proof at all, depending on the course, students, under the guidance of a teacher or as part of independent work, consolidate their knowledge by working with the interactive training scheme. Usually this scheme is accompanied by graphic and / or multimedia illustrations.

Figure 3 shows a visualization of the concept of conditional density in the Gaussian case. Students have the ability to vary parameters and track changes in the density graphs.
Fig. 3. Working with two-dimensional Gaussian density in DLS Nomotex.

Figure 4 shows the training element on the topic «Central limit theorem».

Fig. 4. Training the «Birth of the Gaussian law» in of PTMS e-course.

**4 Organization of students’ practical work in the DLS Nomotex**

In accordance with the established principles, all classroom lessons, including tests, are held in equipped classrooms with maximum immersion in the computer-based learning process. Students have the opportunity to immediately check the correctness of the solution after completing the task, and, if necessary, correct and re-check the answer and / or get advice from the teacher. The teacher, on his /her part, in real time sees on his computer screen the results of the students’ work, the number of solved problems, and their correctness (Fig. 5).
5 Principles of creating and operating a database of problems and test questions on probability theory and mathematical statistics

The described form of the lesson assumes the presence of a large database of tasks and test questions, distributed according to the topics of training sessions and ranked by difficulty. From these tasks, provided there is a sufficient number of them, it is possible to randomly generate both practice and test papers. Moreover, the database of exercises is completely open. If the student has solved the problem, then he/she can enter the answer and check its correctness. The more tasks he/she solved, the higher his/her chances of getting high marks. At this stage, the process of database development is underway.

Figure 6 shows an example of a test question. After completing the work and passing the test, the student immediately sees his/her result.

Fig. 5. Representation of the student's task-completion result in the Personal-account window in the DLS Nomotex.

Fig. 6. Example of a test question for density properties in PTMS e-course.
6 Conclusions

Currently, the development of the general Probability Theory and Mathematical Statistics e-course in DLS Nomotex is practically completed in terms of creating a database of theoretical information. At the same time the work to enlarge the database of tasks and test questions and to create new interactive training content is underway. In test mode, the course was conducted for various student’s groups in 2018-2020. Conclusive results will be obtained in a few years, after the full-scale implementation of the course, but already now, we note the undoubtedly increased interest of the students in studying the subject.

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