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GENERATION OF TRAINING INITIAL-GENERATION CONTENT

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Abstract. *The influence of the automation of content creation on the development trends of e-education based on artificial intelligence is considered. Widely used content generators do not actually create new content but modify the finished content accumulated in the databases. The concept of generating primary content is based on the use of simulation models of the studied objects. The methodology for generating the content initial-generation demonstrates the possibility of incorporating AI-based content management systems into e-education.*

Keywords: *electronic education, artificial intelligence, training content, content generator.*

Introductione

With all the variety of processes taking place in modern education, its main trend is the digitalization of the educational process. This happens so intensively that the question of a person's place in the educational system from the category of philosophical quickly goes into the practical. The volume of classroom studies is significantly reduced, "talking heads" are presented instead of living lecturers, and the question already arises, but what will replace them on the monitor screens?

Relatively conservative trends are still taking shape in the field of creating educational content, there is still room for natural intelligence, but this situation does not seem quite normal. A significant breakthrough can be expected in the automation of content generation.

In this paper, this problem is considered with a simple example, as one of the new promising areas of the introduction of information technology in the educational process.

1. Sources

The digital learning environment opens up new possibilities for both heterogeneous and autonomous learning [1]. The integration of different ways of presenting content means that multimedia learning can be offered on a multi-sensory basis. In addition, much higher levels of both activity and interactivity can be achieved. This increases students' access to research results as well as academic study programs in the media. Collaborative learning plays a much more important role than in traditional distance education. Social networks and other network services are an affordable digital environment for students and teachers to interact [2].

Conceptual modelling of a set of methods for teaching students in information and communication-saturated environment allows us to identify the stages of designing methods for teaching students using a virtual educational environment [3].

E-learning has taken tremendous steps and has set new boundaries in the educational system everywhere, which is a good reason to develop an effective way to create and test special content for it. The development of a conceptual project for digital content creation tools [4] is designed to facilitate the creation, publication, updating and editing of digital educational content with adaptive features.

Deriving used conventional content and laying the foundation for future effective, flexible, and reusable content in e-learning is an achievable and cost-effective goal for many modern training organizations [5]. The key is to convert first-generation curricula (FirstGen) into authentic next-generation content (NextGen), and not just transfer existing curricula to a new format. A key characteristic of next-generation content is that it is divided into separate layers, which include the content itself, structure, presentation, context and pedagogy. Separating these layers simplifies the management, reuse, and personalization of content, and ultimately leads to more effective learning.

Content generators are integrated into many digital learning systems. For example, the method and system for creating, delivering, and administering training materials [6] allows you to quickly develop large volumes of interactive content without requiring the involvement of experts. The system also provides administrative management of the learning process.

The ontology-based approach and the corresponding algorithm [7] are used to automatically decompose learning objects into reusable content units and dynamically assemble such units into personalized learning content.

An ontological approach is also used for creating custom educational content on-demand with automatic evaluation [8]. This system can logically structure educational content and offer several alternative and ranked learning paths so that teachers or students can make smart decisions. The system also has a formal model for automatically generating questions from the domain ontology for evaluation. Using the proposed structure, you can configure various training modules with automatic assessment for people with different backgrounds.

The impact of synthetic bigdata on the training analytics infrastructure is important [9]. The necessity of using the tool on demand to create a wide range of synthetic data is investigated. The use of synthetic data not only accelerates the creation of a complex and multi-level infrastructure for training analytics but also helps to eliminate the ethical risks and risks associated with confidentiality that arise during the development of content.

AI-based machine learning content generator [10] is used in an experiment to create a trained content selection component for generating an object description in a dialogue. Three separate content selection models, based on three theoretical models, all independently achieve accuracy well above the baseline.

The considered educational systems are united by the fact that they are described as single complexes, including the function of generating content as one of the options. However, a different methodological approach is possible [11], which considers training systems as products of integration of knowledge management subsystems and e-learning itself. Knowledge management is a field of research aimed at creating, organizing and storing explicit knowledge for easy access and manipulation, while e-learning is associated with the delivery of a set of knowledge content to a group of students. In particular, knowledge portal systems are usually an effective means of implementing this integration, since new types of content can be created on portal sites for e-learning. The knowledge portal site allows participants to create and share their knowledge objects. Users can further edit and share educational content with other students, creating a collaborative learning environment.

The separation of knowledge management as a separate methodological discourse correlates with the needs of the educational community in creating autonomous content generation systems [12]. A spontaneous process of development by teachers of generators of multivariate educational tasks is developing. Generally, each developer uses his own generators for his own needs, however, sometimes they are applied at the scale of departments or educational organizations. Public information about such individual developments is rather limited, but they attract the attention of corporations, as a result of which online generators of tasks in the form of browsers appear in the network, such as, for example [13-15] and others. These browsers are accessible and convenient to use, however, they are significantly limited in the subjects, variety and difficulty levels of the tasks. Recently, the world's first artificial intelligence platform [16] has appeared on the web to create questions, ratings, and surveys. It turns the content introduced into it into clearly formulated questions.

The gap is widening between rapidly improving teaching systems, using automation and AI approaches, and educational content, which is a variety of modifications of the accumulated traditional content. A special methodology based on multiparameter simulation-ontological models of training courses [17] allows you to create autonomous generators of immanent content. The experience of the practical application of content generators in specific training courses [18] demonstrates its extreme diversity, combined with uniqueness. Pithy tasks and theorems are generated that are absent in existing knowledge bases. The system allows you to vary the subject, complexity and other characteristics of the content while maintaining its methodological unity. The combination of the personality (individuality) of the content with its diversity affects the didactic nature of the educational process and its effectiveness. Both student competition and solidarity in collaborative learning are encouraged. However, higher demands are placed on teachers, and special consulting groups are being formed for their preparation. The extension of the content generation methodology, with the inclusion of not only educational but also a wide range of research tasks, leads to the concept of an intelligent knowledge generator [19].

2. Discussion

Obviously, there is a tendency to increase the importance and autonomy of content management systems as part of educational complexes. They become more perfect, use ontological methods, big data, AI. The prospect of using AI is already visible, not only in the training process but also in "inventing" training tasks. However, if you carefully analyze the existing systems, you can see that they spend their unique resources on converting FirstGen to NextGen, then NextGen to the new NextGen, and so on. Looks like it's time to complete the FirstGen-NextGen design with the IniGen-DeriGen combination. IniGen is the content of the initial generation, that is, that which is defined in the NextGen concept as "the content itself", unlike other attributes that

adapt it to the digital environment. IniGen can include both traditional "manual" FirstGen content and automatically generated initial content. DeriGen includes any content received by processing (modification) of IniGen. This can be either FirstGen or NextGen.

It is regrettable to state that the current generators, in essence, do not produce InitGen content. Those task generators, which, it would seem, are intended for this, actually replicate manually developed tasks in numerous variants, but do not come up with their "own" immanent content. Other generators only rework FirstGen content to NextGen, repeatedly and resourcefully modifying it.

Thus, taking into note the prospects of AI-based education robotization, the problem of generating initial content takes on a priority and fundamental character and requires methodological and technological development.

3. Methodology. By the example of course of differential equations

Content generation IniGen requires completely different approaches than modifying content. Next, we consider a methodology built on a subject simulation model of a training course or its part (training segment). The topic was taken as an example of a training segment: linear differential equations of the first order. In the most general form, these are inhomogeneous equations with variable coefficients

$$\frac{dx}{dt}+q(t)x=f(t) \qquad (1)$$

The peculiarity of mathematical teaching materials is such that often the simulation model coincides with the studied object. This also happens with the equation (1) under consideration.

Since the operations of differentiation are simpler and more visual than integration, the method of solving the equation is formed on the basis of the inverse problem. First, the final general solution of the equation is given

$$x=x\left(t;c(t)\right),$$

where $c(t)$ is the variable constant. This solution is substituted into equation (1).

For this, the total derivative of x

$$\frac{dx}{dt}=\frac{\partial x}{\partial t}+\frac{\partial x}{\partial c}\frac{dc}{dx}$$

is substituted into equation (1) and it turns out

$$\frac{\partial x}{\partial t}+\frac{\partial x}{\partial c}\frac{dc}{dx}+q(t)x=f(t) \qquad (2)$$

If we connect the variable constant with the function $f(t)$ by the relation

$$\frac{\partial x}{\partial c}\frac{dc}{dx}=f(t)$$

then equation (2) will turn into a homogeneous

$$\frac{\partial x}{\partial t}+q(t)x=0$$

with the solution

$$x_0=x_0(t;C),$$

where C=const.

The variable coefficient function corresponding to a homogeneous solution

$$q(t)=-\frac{dx_0}{dt}/x_0=-\frac{d(\ln x_0)}{dt}, \qquad (3)$$

and the function on the right side of the equation

$$f(t)=\frac{\partial x_0}{\partial C}\frac{dc}{dt}. \qquad (4)$$

Thus, the inversion of the solution determines the form of the original equation (as the conditions of the task)

$$\frac{dx}{dt}-\frac{d(\ln x_0)}{dt}x=\frac{\partial x_0}{\partial C}\frac{dc}{dt}.$$

When solving a direct task, the inverse operations applied above turn into direct ones. For example, operations (3) and (4) are inverted, respectively,

$$x_0(t)=\exp(-\int q(t)dt)$$

and

$$c(t)=\int\frac{f(t)}{\partial x_0/\partial C}dt.$$

In a general view, solutions can be formed from typal elements, for example,

$$x=\exp(At)(P_N(t)\cos(Bt)+G_K(t)\sin(Bt)) \qquad (5)$$

where $P_N(t)$ and $G_K(t)$ are polynomials of order, respectively, N and K. Solutions can also be represented as linear combinations of the solutions presented above. Similar approaches are used to generate other differential equations - second-order linear equations, as well as some non-linear ones.

4. Content Generators as E-workbooks

The inverse methodology described above is implemented as a random content generator

(Fig. 1-3). The algorithm begins the procedure by forming the final solution of the form (5), substituteing random coefficients (parameters) into it, and then sequentially calculating and building the in verse operating chain. The procedure ends with the formation of the initial data of the task and the construction of graphs.

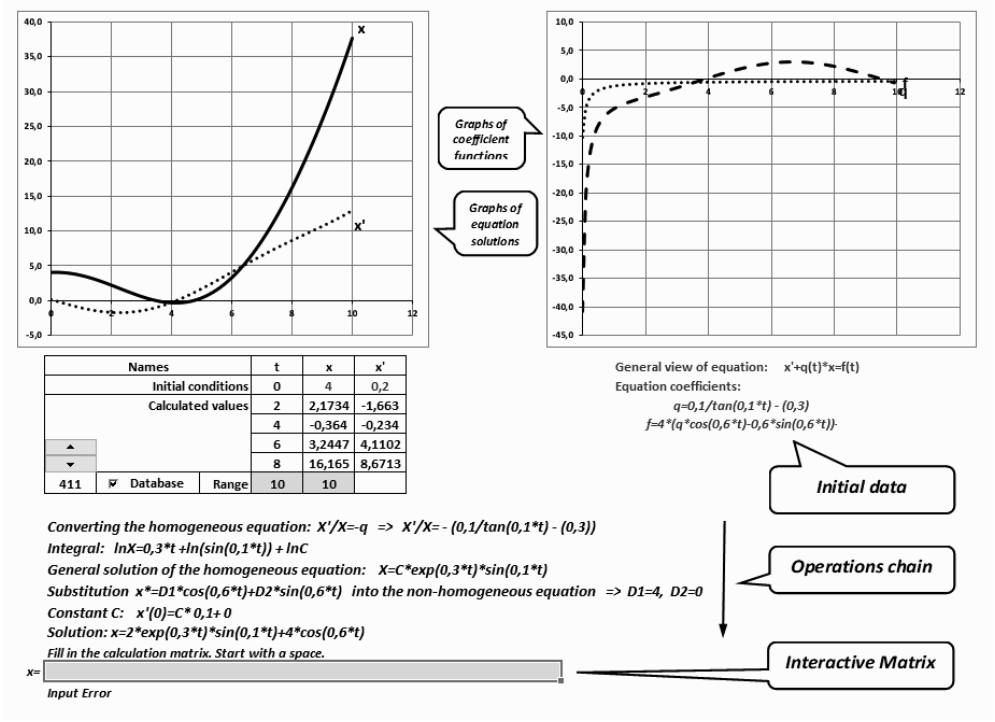


Fig. 1. E-solver (simulator) interface. Inhomogeneous equation, example

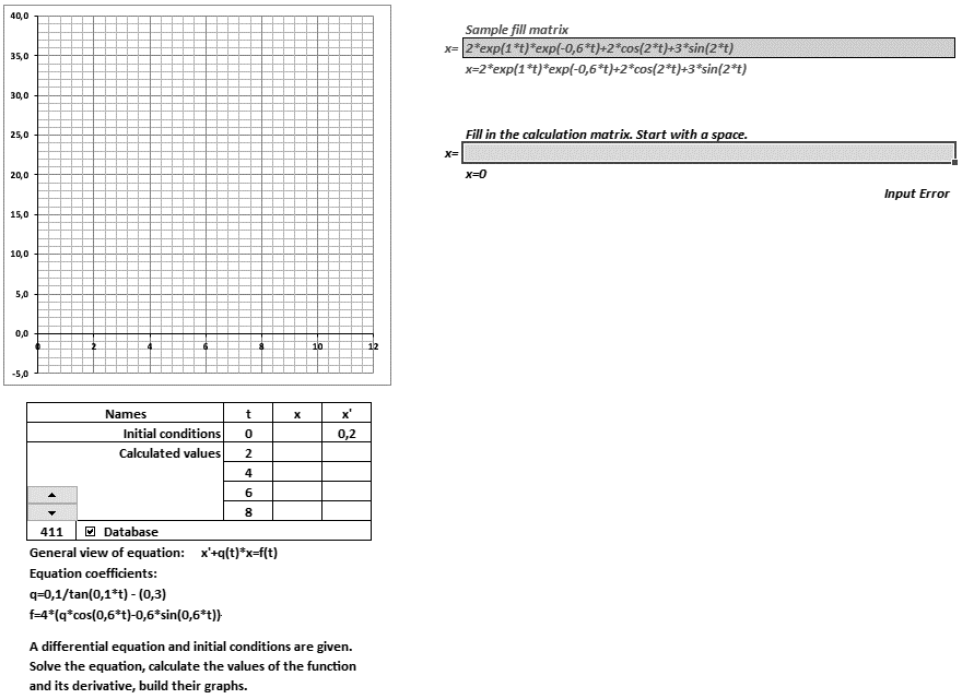
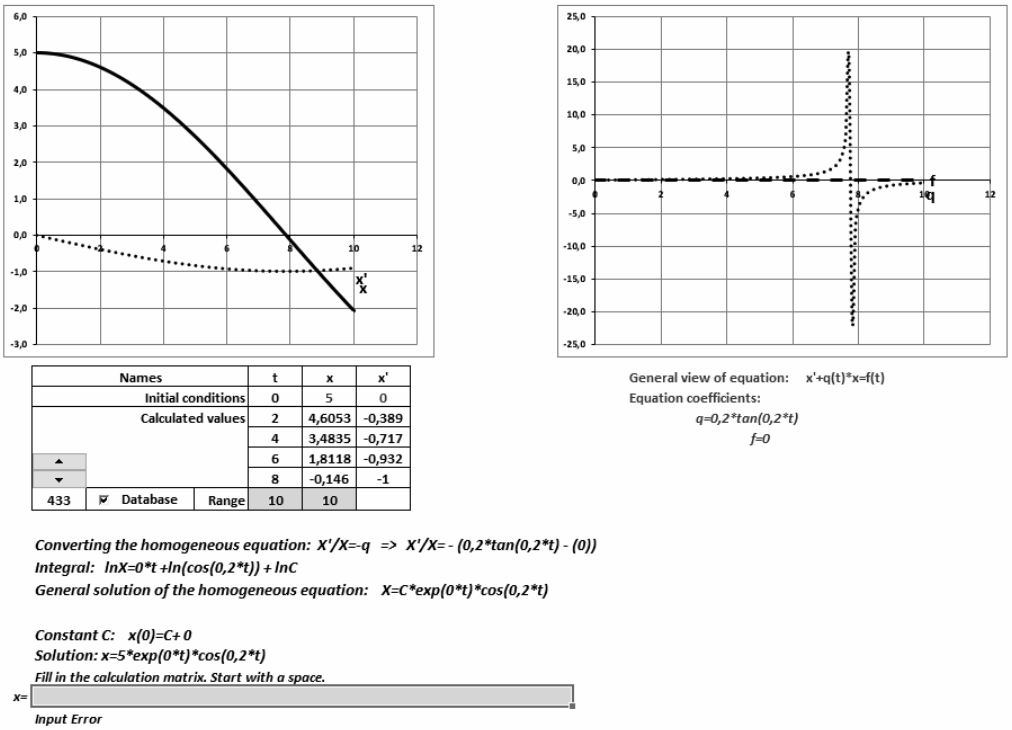


Fig. 2. E-task book interface. Inhomogeneous equation, example

The generator is made in the form of a set of virtual E-workbooks, modified for various applications. Workbooks generate unique (personal) tasks, along with solutions. Random combinations of initial parameters give all possible types of equations: homogeneous, inhomogeneous, with constant and variable coefficients, in various special modifications. In addition, within each type (modification) of

the equation, different types of solutions are obtained: convergent, divergent, cyclic, acyclic (Fig. 4).

Thus, the system generates several dozen types of tasks, providing for each task an unlimited number of random options. Tasks can be structured by topic, complexity and other characteristics. They can be generated not only randomly, but also quasi-randomly - ordered arrays, with identification numbers. In the educational process, E-workbooks of various modifications is used.



Names	t	x	x'
Initial conditions	0	5	0
Calculated values	2	4,6053	-0,389
	4	3,4835	-0,717
	6	1,8118	-0,932
	8	-0,146	-1
433 Database Range	10	10	

Fig. 3. E-solver (simulator) interface. Homogeneous equation, example.

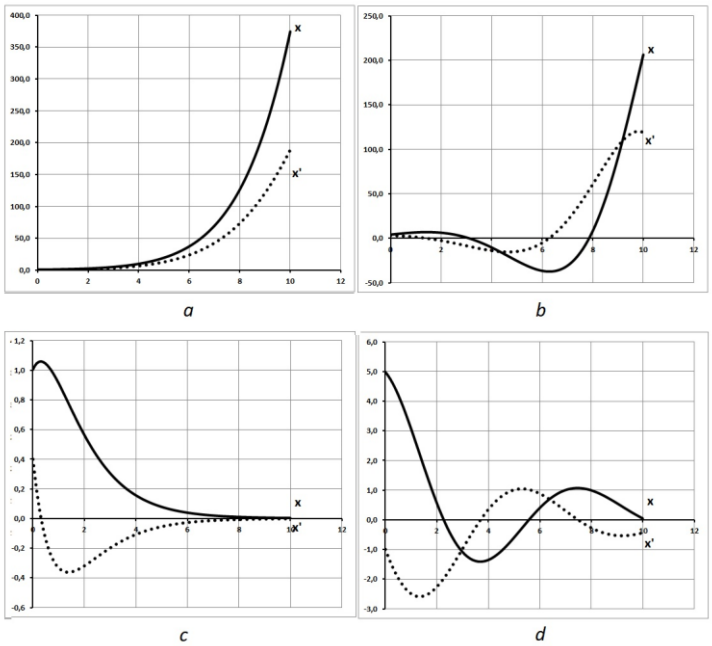


Fig. 4. The main types of solutions:
divergent - a) acyclic, b) cyclic; converging - c) acyclic, d) cyclic.

Simulator workbooks contain random tasks with solutions. They are freely available and can be used as a training reference.

Solver workbooks contain conditions and solutions for ordered arrays of tasks. They are kept by leading teachers and are used as a means of monitoring and diagnostics. Task workbooks contain the conditions for ordered arrays of tasks. They are sent out by leading teachers to their students and are used as sources of personal instructional tasks.

Solvers and task workbooks contain identical arrays of tasks. The student enters a unique number into the task workbook, receives the generated task, solves it and draws up the solution in an agreed form: on paper with subsequent scanning, autonomously in electronic form or by entering data into the working matrix of the task workbook. The solution along with the saved file of the task workbook is sent to the lead teacher. The teacher downloads the saved data from the task workbook to his solver and performs automatic error diagnostics. If necessary, he additionally verifies the student's decision with the data of the solver. Solver data can be presented on a large screen for demonstration and public discussion.

E-workbooks are not an alternative, but an addition to online learning platforms, filling the gap between them and the traditional "paper" learning process.

Conclusion

The real prospects of education robotization apply not only to the educational process itself but also to the development and management of content. The potential of AI-development of content lies in the fact that an intelligent generator is capable of not only modifying existing ready-made content but also generating new immanent content that is adequate to the capabilities of AI. The use of simulation methodology demonstrates the practical possibilities of generating and applying relevant training tasks. Studying and improving such approaches to content management can significantly affect the development of AI-based e-education.

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ГЕНЕРАЦИЯ ОБУЧАЮЩЕГО КОНТЕНТА ИСХОДНОГО ПОКОЛЕНИЯ

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Аннотация. *Рассмотрено влияние автоматизации создания контента на тенденции развития электронного образования на основе искусственного интеллекта. Широко используемые генераторы контента фактически не создают новый контент, а модифицируют готовый контент, накопленный в базах данных. Концепция генерации первичного контента основана на использовании имитационных моделей изучаемых объектов. Методология создания контента начального поколения демонстрирует возможность внедрения систем управления контентом на основе искусственного интеллекта в электронное образование.*

Ключевые слова: *электронное образование, искусственный интеллект, учебный контент, генератор контента.*

ГЕНЕРАЦІЯ НАВЧАЛЬНОГО КОНТЕНТУ ПОЧАТКОВОГО ПОКОЛІННЯ

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Анотація. *Розглядається вплив автоматизації створення контенту на тенденції розвитку заснованого на штучному інтелекті (ШІ) електронної освіти. Реальна перспектива роботизації освіти відноситься не тільки до самого навчального процесу, а й до розробки та управління контентом. Проявляється тенденція підвищення значення систем управління контентом в складі освітніх комплексів і їх автономізації. Вони стають більш досконалими, використовують онтологічні методи, великі дані, штучний інтелект. Видно перспектива застосування ШІ не тільки в самому навчальному процесі, але і в розробці навчальних завдань. Генератори завдань, які, здавалося б, призначені для цього, фактично тиражують в численних варіантах розроблені вручну завдання, але не придумують власний іманентний контент. Інші ж генератори лише переробляють контент з баз даних, багаторазово модифікуючи його. З огляду на перспективи роботизації освіти на основі ШІ, проблема генерації первинного контенту набуває пріоритетний і фундаментальний характер і вимагає методологічної та технологічної розробки. Розглядається методологія, побудована на предметних імітаційних моделях навчальних курсів. Як приклад взята тема: лінійні диференціальні рівняння першого порядку. Генератор виконаний у вигляді комплекту віртуальних електронних робочих книг, модифіко-*

ваних для різного застосування. Робочі книги генерують унікальні (персональні) завдання, разом з рішеннями. Генерується безліч видів завдань, для кожного завдання формується необмежене число рандомних варіантів. Завдання можуть бути структуровані за тематикою, складності та іншими ознаками. Такі робочі книги не є альтернативою, а доповненням до навчальних онлайн-платформ, заповнюючи нішу між ними і традиційним «паперовим» навчальним процесом. Таким чином, потенціал ШІ-розробки контенту полягає в тому, що інтелектуальний генератор здатний не тільки модифікувати існуючий готовий контент, але і генерувати новий іманентна контент, адекватний можливостям ШІ. Застосування симуляційної методології демонструє практичні можливості генерації і застосування відповідних навчальних завдань. Вивчення і вдосконалення подібних підходів до управління контентом може істотно вплинути на розвиток заснованого на ШІ електронної освіти.

Ключові слова: *електронна освіта, штучний інтелект, навчальний контент, генератор контенту.*

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