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Hybrid Intelligence - the Next Stage in the Education Technology

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Abstract

The integration of AI into the educational process is the subject of this study. Particular attention is paid to the technology of creating an up-to-date training sample in the process of use. For this purpose, a hybrid-intelligent bot (HI) under the guise of a student is anonymously integrated into study groups and included in the educational process. The initial training of the bot is carried out on the basis of the program of the current educational course. Then, based on the analysis of the results of regular (after each cycle of lectures) "cross-testing" of participants, additional training of the bot is carried out. The most important feature of cross-testing [1], which allows you to quantitatively and separately evaluate creative and analytical abilities, as well as the ability to make management decisions and to implement them, etc. The HI-bot makes tests on the current topic, which are solved by other students and, in turn, answers the tests made by them. Cross-tests are based on the methods of "fuzzy logic". Each test consists of a task that has an "indefinite" number of correct answer options. The score for the answer varies from 0 to 1, depending on how many options were indicated by the respondent. In addition, the number of test participants who solved the task set in the test and in what time is taken into account. Thus, the assessment of the results of each student consists of at least two indicators. One of them allows you to assess the ability to set tasks, the other - to implement them. The HI-bot is trained on correct and erroneous examples. The process of forming a training sample takes into account the various opinions of the participants. The HI-bot effectively and quickly develops during use, transferring the accumulated experience from one user to another. In the process of communication, thematic orientation of AI arises due to the formation of a new training sample, complementing the existing one and training on its basis. This ensures the specialization of the HI system, which integrates people and AI. Thus, the project implements the basic idea of integrating AI with human intelligence and creates the prerequisites for "training" and "individual education" of HI under the influence of human intelligence.

Keywords: Artificial Intelligence, Hybrid Intelligence, fuzzy logic, cross-testing.

Introduction

Artificial intelligence (AI) is one of the most interesting and rapidly developing areas of technology today. AI systems can perform tasks that usually require human participation, such as understanding natural language, recognizing images, creating new content based on training, and others. The use of AI in the educational process can also give new and very positive results. But for this, the technology of creating an up-to-date training sample and the methodology of learning from positive examples and errors in the process of use are of particular importance. This problem can be solved by integrating the natural intelligence of people with AI. In other words, by creating a hybrid system (HI) (human + AI), modern language models can be taught to take into account the accumulation of knowledge by humanity more effectively. We can say that in this way we provide AI with additional knowledge corresponding to a specific area of use, and provide a person with a new tool that allows them to solve complex problems more effectively. In other words, we provide a person with "additional intellectual resources in a certain direction that develop together with the user and help him solve those problems in which digital methods are faster and more effective than the human brain. In fact, this task is similar to the individual education of people from childhood, when they learn and accept rules of behavior based on the experience of parents, teachers, friends, etc.

HI is characterized by a high degree of involvement in communication with a person and third-party software. The level of data classification and context recognition remains largely the same as in generative language models. A qualitatively new result is achieved through training based on the principles of fuzzy logic [1]. In other words, we must teach AI not only to find the most plausible answers to the questions posed, but also to build hypotheses about how the interlocutor will perceive them. This is the approach we are trying to implement through joint training of an intelligent bot built on the principles of LLM and students from educational institutions of different focus. In the process of joint training, data is accumulated, moderated by the teacher and the students themselves. This is data on “bad and good” answers to the questions posed by the bot for testing students. And vice versa. About what questions the students asked the bot and their fellow students using the so-called cross-testing method [2]. Such algorithms are able to learn to "anticipate" the reaction of a human interlocutor and gradually learn not only to answer, but also to ask questions taking into account the understanding of the interlocutor's psychology. This can become the basis for making the use of existing AI models more effective. For this, they can be integrated with human intelligence during training (hybrid intelligence). It is this quality that distinguishes people who are better able to set tasks for others from those who can only solve tasks set for them. Thus, the integration of AI under the guise of a participant or user into an interactive system at the earliest stage for information interaction with members of social communities can create qualitatively new properties and at the same time reduce the negative effects of losing control over it. To achieve this, it is necessary to learn how to introduce AI into human communities of various purposes unnoticed by other participants of the community.

1. Discussion

In the process of communication, thematic orientation of AI arises due to the formation of a new training sample, complementing the existing one and training based on it. This ensures the specialization of the HI system, which integrates people and AI. Such a "hybrid mind" has huge advantages over separate human and artificial intelligence. Dynamic learning in the process of communication creates new opportunities and becomes the most important incentive for the development of such systems. We begin the implementation of hybrid systems in practice with the educational process. For this, cross-testing technology is used, in which students test each other, but among them there is a "smart bot" (AI) (Figure 1), imperceptibly participating in the educational process and learning together with students. The bot can participate simultaneously in many learning communities, in different specializations and with different compositions of participants. Thus, it will be possible to compare different students and different groups by levels of training, based on the level set by HI.

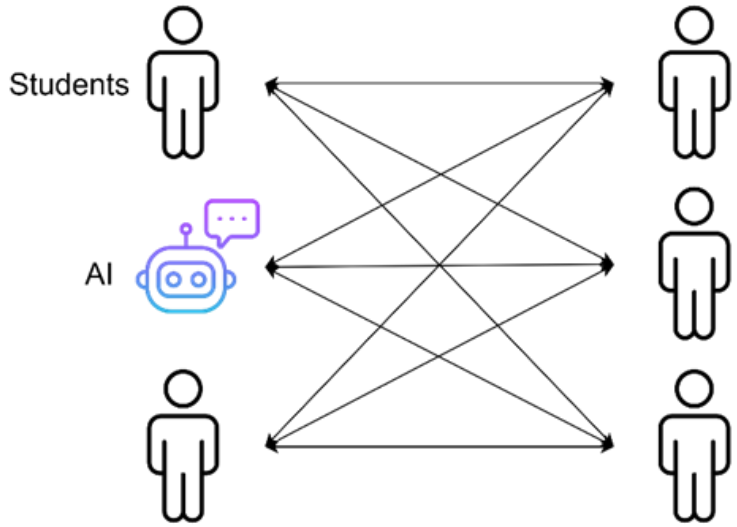

Fig. 1. Cross-testing stage

HI cannot become “very smart” overnight. This is a gradual process of integrating different APIs and their capabilities, as well as tools for automating their work. First, a standard configuration is turned on, which works in parallel with a person, and an additional sample for training is formed based on the decisions made and executed.

HI collects all the primary data and forms a draft control decision (grades given by cross-testing participants, for example), which is confirmed by the relevant specialist - a person (a teacher, a moderator). The results of executing these decisions are used to train the bot. In this case, training

uses the principles of fuzzy logic. In other words, grades are not made on the “yes-no” principle, but can have several levels. At the same time, achieving the maximum grade in each test is not mandatory. And the bot learns to take such uncertainties into account when forming a personal characteristic of the student. This assessment is part of his “digital image”, which, in turn, is taken into account in the document issued based on the training results. Formation of a digital image of a student is a task that we are actively promoting to the educational market and we hope to attract attention to the use of technology based on cross-testing together with an "invisible bot" integrated into the educational process to an international audience. When granting HI freedom and rights to perform actions on behalf of the user, an acute issue of personal data security arises. The current architecture of client data exchange between different services is not able to protect against mass hacker attacks. Therefore, two-factor authentication protocols and other additional protection contours have already become a familiar norm for any user. If we want to transfer to HI the rights to perform most of our routine tasks related to personal and work correspondence, bank transfers, purchases in a store and much more, we must provide the ability to verify HI's actions, as well as reliably protect the entire perimeter from the actions of third parties.

Why is HI something fundamentally new?

Let's first look at Wikipedia and see the definition of language models. Language models, or more precisely language modeling, are probability distributions over sequences of words. That is, generative language models were originally designed to find matches from an array of data and predict the correct word. Such models were not created to follow instructions. Predicting the next word in the text and understanding the processes of completing tasks are not the same thing. However, thanks to the use of modern methods and approaches, generative artificial intelligence has learned to understand and follow specific instructions for different processes.

One such effective method can be called "reinforcement learning based on human feedback (RLHF)", where a pre-trained language model is sent to test its responses to real people [3]. This method is behind the "humanity" of all OpenAI models. It is this method based on data with real person verification from people that allowed them to train their language model and make the answers close to the answers of a real person. Algorithms with complex human values and understanding of context are becoming the next stage of the evolution of generative artificial intelligence. Our project implements the basic idea of integrating AI with human intelligence as a single HI system and creates prerequisites for "training" and "individual education" of AI under the influence of human intelligence. It is possible that in this approach new forms of relationships between people may arise, each of whom will interact with their own intelligent assistant. In this case, social systems of a higher hierarchical level may arise, which form a "collective mind".

2. Algorithm of Work

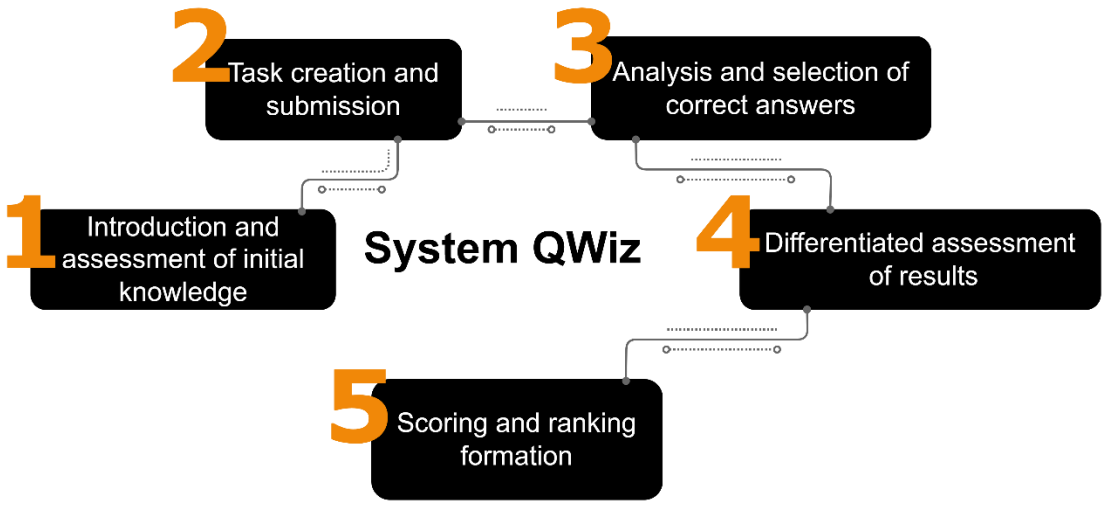

Fig. 2. Structure of the dynamic ratings formation system

Let's consider an approximate algorithm of the HI-based system, which includes five stages (Figure 2).

Stage 1.

- Preliminary training of the HI-bot. It is implemented on the basis of a limited sample, compiled on the basis of sources specified by the teacher in the program of the training course and general materials in this subject area (taking into account the specifics of the classroom).

- Study of the next topic of the training course independently and/or in a lesson with the teacher.

Stage 2.

- Compilation of tests for colleagues in the study group. Completed by all students, including the HI-bot after each thematic cycle or lesson. In this case, instructions are taken into account, in particular, on the principles of fuzzy logic when formulating tests and answers to them (the test must contain "fuzzy" in the mathematical sense tasks).
- Distribution of compiled tests at the next cycle of classes randomly for answers to colleagues in the educational process. At the same time, there are rules that exclude the possibility of obtaining your own tests for answers and other restrictions that protect against unfair use.

Stage 3.

Solving test problems. If necessary or at the teacher's request, students explain the test with examples and theoretical justification of correctness (indicating links to theoretical materials. As a rule, they are implemented at the beginning of the next lesson.

Stage 4.

- Evaluation of each student's solutions by selecting answer options, receiving feedback and commenting on it. Correct. The assessment is multi-level and takes into account the accuracy and completeness of the answers. This assessment mainly characterizes the quality of assimilation of the educational material by each participant and is used to form one of the components of his digital image (an indicator of the ability to analytical activity [4]).
- Evaluation for the correctness and quality of the compiled tests is carried out based on the results of each lesson or thematic cycle. It is carried out based on the results of processing all the answers of a group of students on the current topic and takes into account the solvability of the majority of students (but not all). As a result, an indicator of "creativity" is formed, showing not only the level and quality of acquired skills and knowledge, but also the ability to take into account the reactions and opinions of others.
- All assessments are based on the results of data processing using robust statistics methods (assessment by the moving median of the values of the indicators obtained in 5 consecutive lessons), which ensures the exclusion of unreliable results)

Stage 5.

- Dynamic assessment of the ratings of the indicators of "creativity and analytical skills", which characterize the progress in obtaining and assimilating knowledge and skills obtained in the learning process and the ability to implement them in professional activities as leaders and performers.
- Assessment of the quality of the educational process based on the results of each testing cycle.
- Creation of internal competition based on a comparison of the ratings of different students (game and competitive elements).

Identifying a problem situation is a stimulus for thinking activity, initiated by the need to solve the problem. In learning, questions perform the following functions [4]:

1. Teacher's (textbook's) questions:

Controlling - teacher's (textbook's) questions check students' knowledge;

2. Student's questions:

a) Thinking - student's questions show the level of logic and thinking activity;

b) Speech - questions develop speech and enrich vocabulary;

c) Signaling - questions show the student's "involvement" in the process and his knowledge or gaps.

Our system includes both types, however, it is the questions asked by students that involve the most important functions in successful learning. Learning connects the general and the specific, creating a connection between theory and reality. In order for theoretical knowledge to become understandable, it is important for students to realize its real cognitive significance.

Problem solving is a method that combines the processes of concretization and generalization. The process of solving specific problems is a continuation and deepening of the assimilation of theoretical material and filling the theory in the minds of students with specific content that reveals the vital significance of concepts, formulas or rules. When independently composing problems, students connect the theory with personal experience, which is reinforced by the student himself in those examples that are filled with meaning specifically for him and makes knowledge more significant and systemic [5].

Selecting life material to illustrate their tasks helps students see the practical significance of "boring" theory and increases interest in the subject. Material from personal experience serves as a starting point for formulating a task, in which the imagination plays an important role, subject to analysis and intellectual testing for compliance with the goal set by the student himself.

To successfully formulate a task, students need to turn again to theory to identify the essence of the problem and find solutions, which activates analysis and memorization. At the stage of formulating a question, the results of mental activity are recorded in various expressions (verbal, mathematical, graphic), which develops logical thinking, communication skills and speech culture. An important element of the tasks of the type (multiple choice) is the selection of several answer options (one correct and several incorrect ones, which is done in accordance with the principles of fuzzy logic. [6]. The correct answer must be supported by theory, examples or solutions with references to sources. The selection of incorrect answers requires taking into account typical errors. Thus, composing one task or question is a process that requires thoughtful work with theory, thinking about the wording of the question and a deep analysis of possible answer options.

3. Motivation and Evaluation System.

A necessary condition for completing all these steps is to motivate students to create non-standard tasks on the image, original tasks with a sufficiently high level of complexity. How to achieve this? The leading role is given to the differentiated assessment system and the competitive component of the system.

Of great importance in achieving the desired goal is a clear explanation of the requirements for tasks (independence, relevance, logical and grammatical correctness), with examples clearly explaining typical errors and the reasons for their occurrence. Before completing the tasks, participants receive information about the principles of the system, explaining the algorithm for independently composing tasks among other students in the group and the criteria for assessing the correctness of answers to the task (task rating) and the correctness of its composition. The algorithm of the system in question sets the task in a random order, which leads to a minimal opportunity to write the correct answer in such a way that the same task is applied to ordinary students.

Depending on the percentage of correct answers, the task is classified as "simple" (81-100% correct answers) with the minimum number of points applied or "solvable" (30-80% correct answers) with an increased number of points assigned in the system. It is important to draw the student's attention to the fact that the proposed incorrect answer options can both complicate and simplify the solution (for example, the possibility of choosing a method for excluding the correct answer), and therefore their choice requires a thoughtful approach. Situations where there are several options for solving the problem are discussed separately. If the number of incorrect answers is less than 30 percent, there is a possibility that the task/answer options are composed incorrectly or the problem belongs to the category of increased complexity. In this case, the system assigns this task an "alarm priority" and sends it to the teacher for saving, who recognizes it as either "erroneous" or "difficult", with the corresponding assignment of points.

Depending on the goals set by the teacher, "difficult" tasks may be rated higher than "solvable" or not. A correctly composed task with correctly selected answer options and clear argumentation of the correct solution optimally corresponds to the task of group learning in the system. "Alarming priority" can also be set by the student at all stages of solving problems (both the teacher's and other students'), in cases of incorrect (in the student's opinion) formulation of the problem, disagreement with the solution presented by the author, lack of logic, overload/lack of information, etc. Setting "alarming priority" should be explained and/or supported by a solution and answer option different from the author's. Tasks with "alarming priority" from students are sent to the teacher for arbitration, who either awards an increased number of points for "criticality" or deducts points for "unreasonable claims". Thus, students not only act as teachers for each other, which in most cases is already a powerful motivational stimulus for creating non-standard tasks, but also come to the understanding that in order to get the maximum number of points, it is important to choose the right tactics when composing a task, taking into account all possible assessment scenarios. Subsequent analysis of the best tasks helps to improve the image assessments of the social group that is considered authoritative for the student.

In the proposed system, the assessment of the success of learning is differentiated and consists of several components:

a) analytical thinking - the ability to work with information and identify internal relationships when composing a task, selecting possible answer options, correct answers to the teacher's questions and tasks of other students, etc.

b) critical thinking - assessing an independently compiled task for compliance with the assigned task and reviewing the correctness of other students' tasks.

c) creative thinking - selecting data to reflect theoretical issues in an independently compiled task, considering options for an erroneous solution to a problem, formulating a question, etc.

Despite the fact that not all tasks submitted to the system by students will be ideal from the teacher's point of view (due to misunderstanding of the material, lack of necessary data, incorrect use

of vocabulary, etc.), their comprehension and solution by other students in the group provides an opportunity to see the diversity and peculiarities of other people's thinking, develops tolerance, interpersonal communication, helps to learn to argue their position and develop their own system of views and values.

Analysis of errors in independently compiled tasks helps to identify individual gaps in the knowledge of each student and determine what exactly causes difficulty (misunderstanding of theory, lack of logical connections, errors in calculations, inattention, etc.).

As a result of data processing, the teacher and student can objectively assess the result of mastering a specific topic, the presence of skills in using knowledge, and the level of creative and analytical abilities (Figure 3.). With this data, the teacher will be able to develop individual recommendations for repeating certain topics, expand the theory with additional materials to develop the interest shown, and recommend paying attention to the use of certain skills, which is practically impossible with the traditional approach.

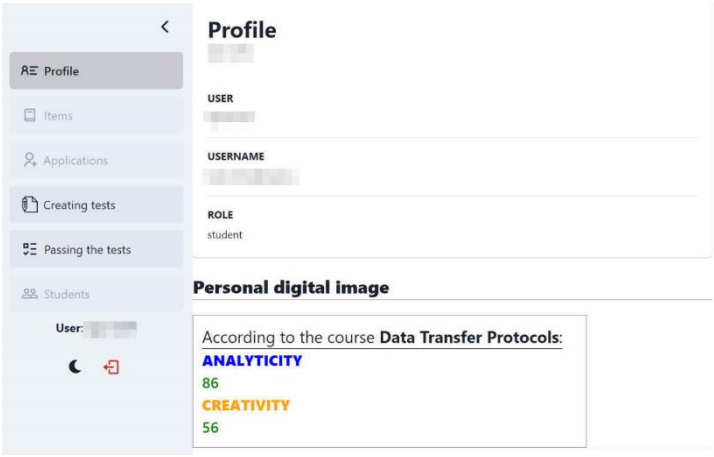

Fig. 3. Student profile with established ratings by subject.

The system generates student ratings that show not only the level and quality of acquired skills and knowledge, but also the dynamics of their change over time, make it possible to compare the results of different students or groups of students (personal and team competitions) and reflect the dynamics of the learning process. Ratings are generated based on the principles of robust statistics and are stable in the mathematical sense estimates of the processes under study. Progress or regression in the learning process of each student is determined based on an assessment of statistically significant increases or decreases in ratings over the monitoring period. The proposed system can be used at all stages of education, from primary school to higher and professional education. It is adaptive and suitable for groups of any age and level of training. On its basis, it is possible to form unified knowledge bases on various subjects (humanities and exact sciences) with constantly updated test banks. The modular structure and clear interface, with the ability to download data in various digital formats, allows you to use the entire system or part of it (for example, only the theory module and installation tests) depending on the goals and objectives of the teacher.

Conclusion

The way from generative AI to hybrid intelligence (HI) has already begun. We have made significant progress in transferring knowledge to AI to plan, solve problems independently, use external tools, and follow instructions. HI will continue to evolve in how it interacts with systems controlled by people and neural networks. Researchers in the field of HI are bringing us closer to a future in which AI can be an active assistant to a person or a community of people of different types, and also manage complex tasks together with a person, becoming more than just an assistant for the user in his daily tasks. In other words, it will be able to fully take over most routine processes.

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