Hybrid Intelligence - the next stage in the education technology

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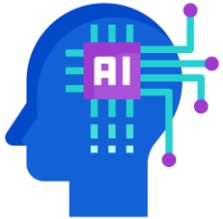
Continuous learning throughout life

Continuous learning is a key aspect of personal development in today's world.

- The use of AI in the educational process can 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.**

Fuzzy logic testing



- A qualitatively new result is achieved through training based on the **principles *of fuzzy logic*.** In other words, we teach AI not only to find the most plausible answers to the questions posed, ***but to build hypotheses about how the interlocutor will perceive them*.**
- This is the approach we are trying to implement through joint training of an AI-bot built on the principles of LLM and students from educational institutions. 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. 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.

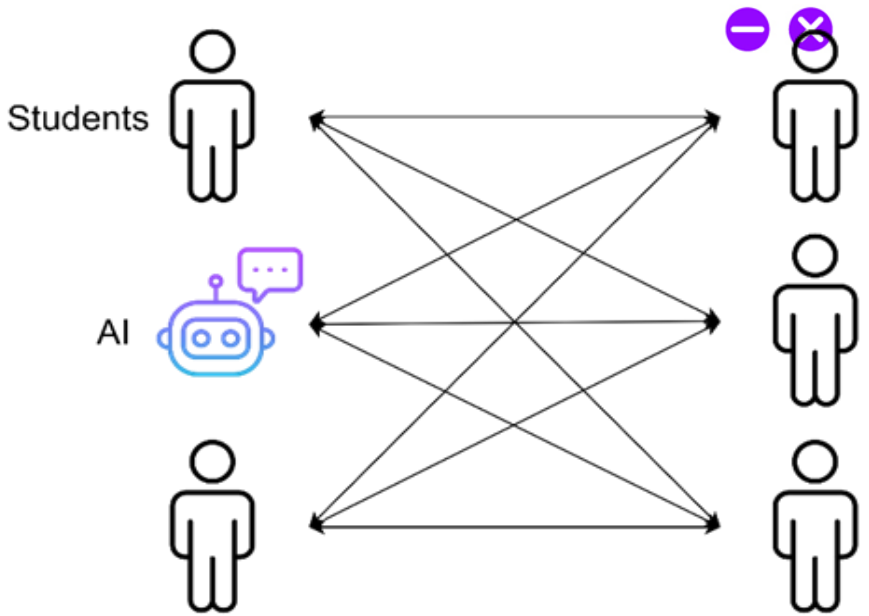
Hybrid intelligence

- When students and the AI bot communicate, the thematic focus of the AI -bot arises due to the formation of a new training sample in the process of cross-testing. This sample regularly supplements the existing one and ensures the "intelligent" development of the bot. ***In other words, it integrates people and AI.*** Such "hybrid intelligence" (HI) 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 begun the implementation of hybrid systems in practice with the educational process***. For this, we use cross-testing technology, in which students test each other. Among them there is a ”AI-bot" which imperceptibly participates in the educational process and learns together with the students.

- Since one AI-bot works in parallel with different groups of students, then through the obtained statistically averaged "dynamic digital images" it is possible ***to compare students from different groups and different groups by levels of preparation.***

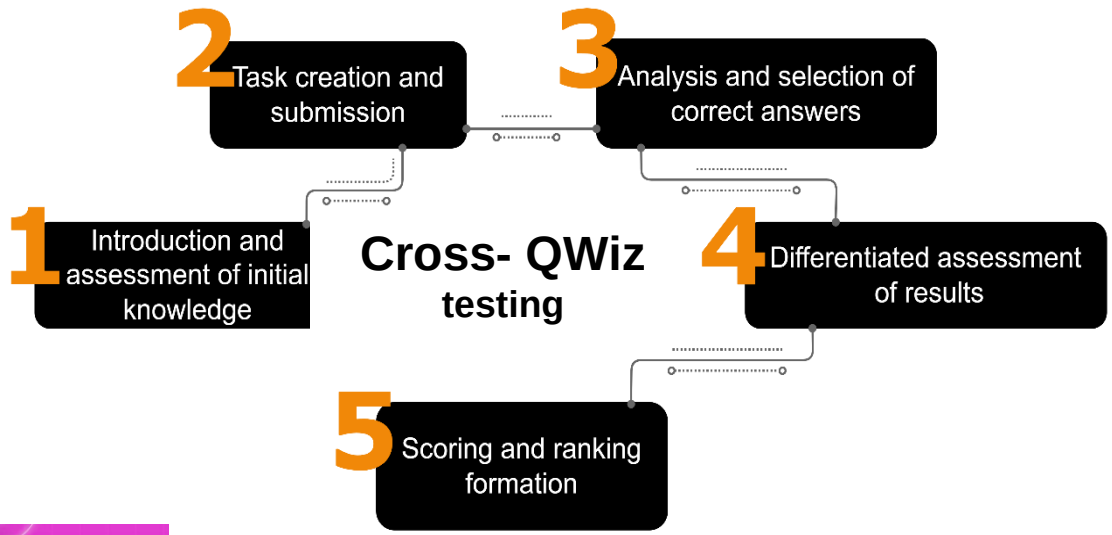
Cross-testing is one of the variants of fuzzy logic testing

- The implementation of HI begun from education process, ***when AI-bot participates in cross-testing, learning alongside students***
- AI collects primary data and forms a ***draft of the management decision*** (e.g., assessments in cross-testing), which is then validated by the instructor or moderator
- The results of these decisions ***are used to train the bot using fuzzy logic principles,*** where assessments are not limited to a binary choice but can have multiple levels



Algorithm of work

- **The key component of the HI system is the skill of independently formulating tasks**



- **A question is not just a request for information, but a reflection of the questioner's knowledge and its connection to a problem situation**

Assessments of successful completion

Analytical skills

The ability to systematically analyze presented data and information

It is **calculated** using the robust mean formula:

$$RM = med(X),$$

where X is the set of scores obtained by the student across all tests

Creativity

The ability to find unconventional solutions, form interesting and sufficiently complex questions

It is **calculated** using the formula:

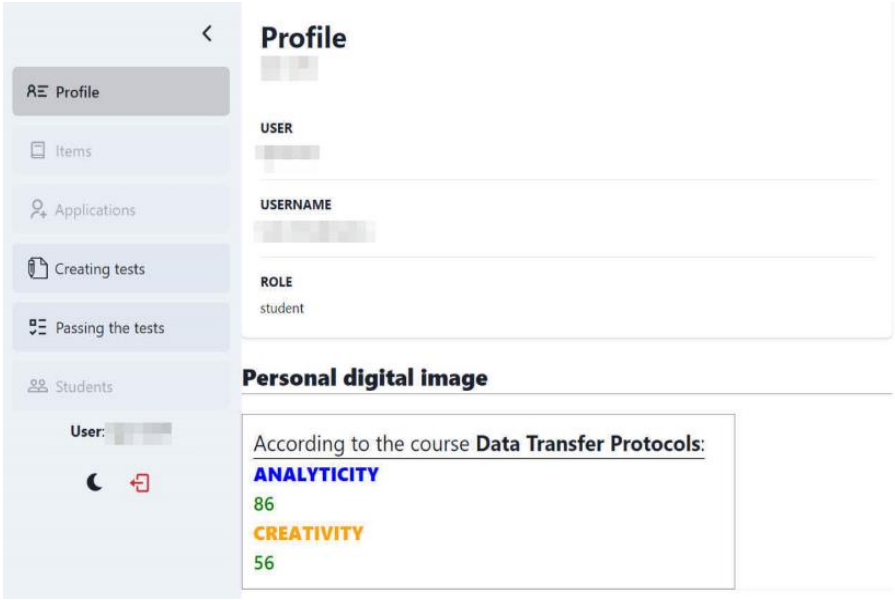
$$RCV = IQR/med(X),$$

where IQR is the interquartile range, and X is the vector consisting of the proportions of correct answers to each question on the test

Conversion of results into grades

RCV< 10: assessment “2”	RCV < 20: assessment “3”	RCV < 30: assessment “4”	RCV ≥ 30: assessment “5”

Data processing result



- The **Cross-Quiz** system generates student rankings that reflect the level of knowledge, learning progress, and comparison of results
- It provides an objective assessment and stimulates the educational process through ***dynamics cross-testing, automatic analysis of results, and the use of fuzzy logic***

Conclusion

- *The way from generative AI to hybrid intelligence (HI) has already begun.*
- *Significant progress has been made in integrating the HI-bot into the learning system.*
- *This makes it possible to quantify intellectual abilities and the quality of acquired skills to form a dynamic digital image of a person throughout his or her life.*
- *These results can be used as a basis for self-development and career choice.*

Thank you for your attention!

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Sincerely,
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