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NAMED AFTER MUHAMMAD AL-KHWARIZMI

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INTERNATIONAL CONFERENCE ON INFORMATION SCIENCE AND COMMUNICATIONS TECHNOLOGIES – APPLICATIONS, TRENDS AND OPPORTUNITIES

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PREFACE

The 2023 IEEE and IFIP International Conference on Information Science and Communications Technologies ICISCT 2023 invites high-quality recent research results in the areas of Home and Health networking, Electronic commerce, Mobility and Mobile Payment, Broadband access, satellite services, 5G in rural communications, cloud computing, Smart grids, Big data analysis, Cyber security, Internet-of-Things IOT, Mobile and Wireless Communications, optical communications and networking, architectures, protocols, planning and design, management and operation, simulation and performance modeling.

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The main goal of the conference is to bring together scientists and engineers who work and teach in these specialized fields to submit papers and come together in this geographical location. ICISCT 2023 is sponsored and organized by IEEE Uzbekistan Regional Chapter and Tashkent University of Information Technologies TUIT and Technically Sponsored by IEEE Photonics Society https://www.photonicssociety.org

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Overview of The Educational Platform for Predicting and Classifying of Pupils' Knowledge Based on Artificial Intelligence

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Abstract— **In this paper, we will overview the educational platform in order to predict and classify of pupils' knowledge. The platform is designed for middle and high school. However, the platform is flexible. This educational platform is based on machine learning (ML) algorithms that is subpart of artificial intelligence (AI). The architecture of the platform, machine learning algorithms to create the educational platform and other techniques (web frameworks, machine learning frameworks, data base management systems and so on) technologies in order to create the educational platform are overviewed. The architecture of educational platform is composed of three layers, namely: access the platform layer, predicting and classifying of pupils' knowledge layer and results layer. The platform can independently carry out predicting and classifying pupils' knowledge as well as can be assessed pupils' knowledge.**

Keywords— educational data mining, artificial intelligence, machine learning, educational platform, perceptron, ann, k-nn, naïve bayes, decision tree, svm

I. INTRODUCTION

Recent years, we have observed some educational platforms based on AI. AI helps effectively in order to solve many problems in education. In particular, we observed that AI is useful in the coronavirus pandemic. Nowadays, the role of AI in education is increasing. For instance, according to research, the role of AI in US education sector could be increased up to 47.77 percent between 2018 and 2022. The role of AI in the education sector is also increasing in other countries. The educations and applications that are based on AI has three main principles, namely learning, self-correction and reasoning. Four forms are presented: assisted intelligence, augmented intelligence, automation and autonomous intelligence. Moreover, we discuss about the role of AI in education in the discussion section.

Educational Data Mining (EDM) [2] is defined the intersection of education and AI. EDM is subpart of AI. EDM could be determined as the technique in order to find the specific types of data that come from the education system. The techniques EDM implements to define pupils' knowledge. EDM is the process of transforming raw data obtained from educational systems into useful data that can be used to make data-driven decisions. The development of data mining and analytics in the education field was relatively late as compared to other fields. Yet due to its specific features on data, it is used to challenge for educational data mining via the Internet. While several types of data have consequential aspects, the distribution of educational information over time has incredible attributes. EDM includes AI (machine learning algorithms, data mining and so on), pedagogical methods to improve pupils' knowledge and information technologies.

One of subparts of computer science is Data mining (DM) [3]. DM is used to discover different factors and patterns in order to make decision. Figure 1 depicts Educational Data Mining. DM could be encouraged Institutional Memory. DM is also known as KDD. KDD stands for Knowledge Discovery in Databases. KDD refers to "Mining" or extracting knowledgeable data from huge data sets. Educational systems have great educational databases. This data is composed of following data. Such as teacher's data, accounts data, pupil's data, alumni data and so on. EDM focuses on the development techniques in order to explore the spectacular types of data that obtain from an educational context. These data obtain from different sources [4]. These data are obtained from the traditional face-to-face classroom environment, online courseware, educational software [16].

DM methods are used to perform on huge data sets to find hidden patterns and relationships, that is useful for lots organizations to make data-driven decisions. Several techniques and algorithms such as Association Rules, Genetic Algorithms, Decision tree, Clustering, Classification, Regression, Neural Networks are used to discover knowledge from databases. EDM includes AI (machine learning algorithms, data mining and so on), pedagogical methods to improve pupils' knowledge and information technologies.

Currently, below educational platforms and applications that is based on AI are using in different stages of education [18].

The platforms based on AI have been indicated to be highly effective at increasing pupils' and pupils' performance and motivation. For instance, Memrise, Kidaptive, Querium, Nuance, Knewton, Cognii, Centry Tech, Carnegie learning, Blippar, Thinkster Math, Volley, Quizlet.

The educational platforms mentioned above and applications aim to teach pupils in which are different ages. Above educational platforms and applications are designed for pupils, undergraduate pupils and graduate pupils. However, we consider the education platform that is designed for 5th to

11th grade pupils in the middle and high education of Uzbekistan [1].

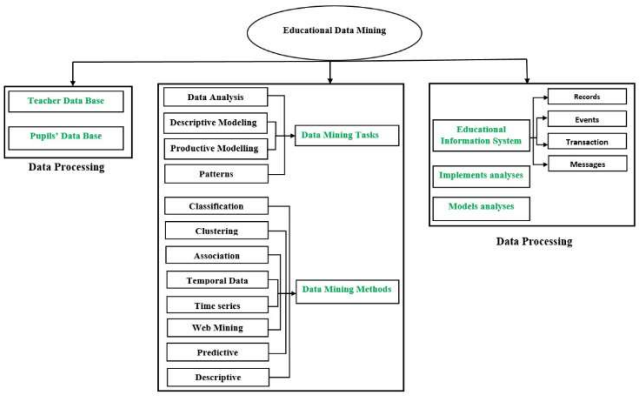

Fig. 1. Educational Data Mining

The purpose [5] of the educational platform is to teach the pupils deeply by predicting and classifying pupils' knowledge. In the sections of this paper, we will overview the architecture of educational platform based on AI that is composed three layers, machine learning algorithms to create each layer, web techniques, use-cases and benefits of the educational platform.

II. Architecture Of Educational Platform

In this section, we overview the architecture of the educational platform. Above mentioned, the platform consists of three layers. Table I fully describes the architecture of the educational platform.

TABLE I. Architecture Of Educational Platform

EDUCATIONAL PLATFORM		
LAYER 1	LAYER 2	LAYER 3
Access the platform	Predicting and classification of pupils' knowledge	Results

We will overview each layer of the architecture and the function [6] of the platform in detail. Layer 1 that illustrates in Figure 2 is called as an access system the platform. In this scenario, when a pupil accesses the platform, pupil's psychological state is determined by test in the first layer [7].

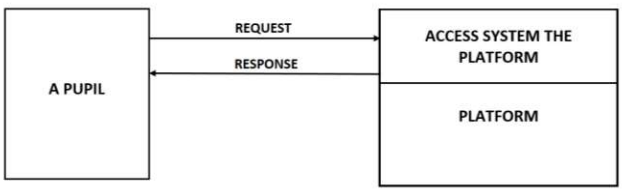

Fig. 2. Layer 1

The pupil that passed successfully from the first layer can be chosen the subjects from the second layer corresponding to the pupil's grade. Before choosing the subject, a pupil has to register in the platform [8]. The second layer of the platform is determined predicting and classifying pupil's knowledge. Figure 3 illustrates Layer 2. The layer 2 is composed of four subparts. First subpart depicts the set of grades between 5th and 11th. Second subpart depicts a set of subjects. Each grade could be able various number of subjects depending on a grade. Each subject has various number of modules that illustrated in the third subpart. Last subpart illustrates each module consists of different complexity levels of tasks, namely: lower, medium, higher. Each level of task has educational materials to study a subject that is composed of recordings, videos, animations, graphic and different types of document (doc, pdf) materials. The pupil has to take an exam to pass the next level. Exam forms could be related to the subject such as: a test, reading, writing, listening, speaking, exercises and etc.

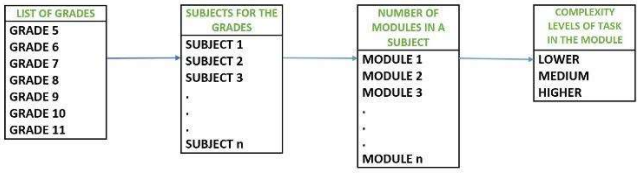

Fig. 3. Layer 2

Last layer is for pupils' results that illustrates in figure 4. After successfully passed the psychological test in the first layer, a pupil can choose the grade. Therefore, a pupil need to finish each subject in the grade. When a pupil chooses the subject, the platform suggests a pupil the test in order to identify pupil's level that a pupil chose from a subject. Depending on a result of the test, a pupil can be started studying educational materials correspond to a pupil in the module/level. In the end of each level of task in the module, a pupil has to take exam to pass next level of task. The result of exam could be poor, average, good, excellent. The result of exam in the complexity level of a module will be poor, the pupil will be back the previous level. if the result will be average, the pupil need to study the level. Otherwise the pupil can pass the next level. after completing all levels, the pupil can pass the next module.

Four categories of score can be able in the platform that poor equals to two, average equals to three, good equals to four, excellent equals to five. If a pupil fails exam, the platform could be allowed a pupil to study the task several times.

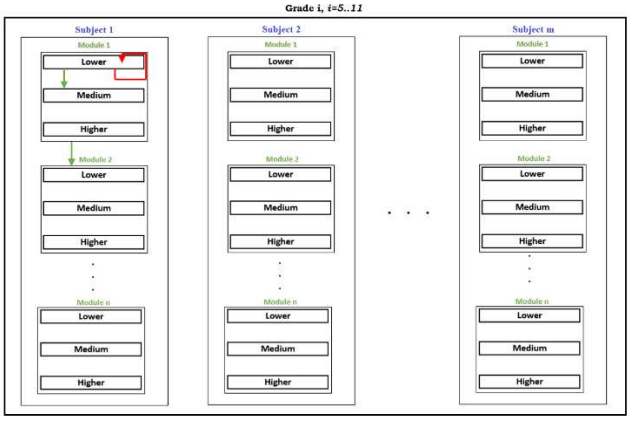

Fig. 4. Layer 3

After a pupil finishes every level of task successfully, a pupil can pass next module.

Finally, after finish every subject in the grade, a pupil can pass next grade. In the end of grade, the platform determines pupil's average score. After completing all the subjects in the grade, the platform allows a pupil to transfer to the next grade [10]. Average score of a pupil is determined in the grade. Thus, at the end of 11^{th} grade, the pupil's total score is determined after completing all grades. Total score of a pupil in the end of 11^{th} grade is related to average score in each grade from 5^{th} grade to 11^{th} grade [11].

III. Creating Methods The Platform

The platform could be created in the form of a mobile app (Android, iOS), a desktop app (Windows, Mac, Linux). However, in this scenario the platform is created in the form of a website. Therefore, Django framework should be used in the back-end side of the web-site, because basic programming language of Django is python. The front-end side should be created by HTML, CSS, JS and Vue.js and Node.js. The database part is created using relational DBMS (PosgreSQL, SQL Server, SQL Developer, MySQL).

In the first layer of the platform, the psychological state of the pupil is determined using a perceptron, a single layer artificial neural network that is illustrated Fig 5. A binary classifier in machine learning is a type of model that is trained to classify data into one of two possible categories, typically represented as binary labels such as 0 or 1, true or false, or positive or negative.

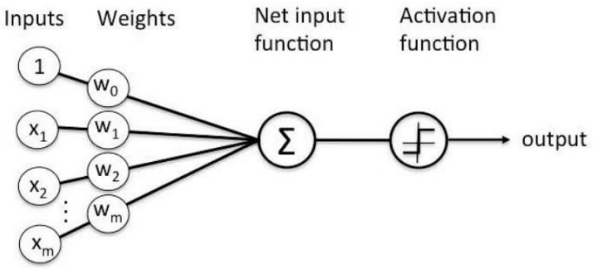

Fig. 5. Single layer artificial network. Perceptron

Psychological test questions are taken as perceptron input values. Input values transmit to the following function.

$$\sum_{i=1}^{n} w_i x_i + b \qquad (1)$$

Formula (1) helps in order to create mathematical model accessing the system, where $n -$ number of psychological tests that given to pupils. The perceptron is identified that a pupil can be accessed the platform [13].

An activation function $g(z)$, where if $g(z)$ is greater than a defined threshold θ we predict 1 and -1 otherwise in Formula (2);

$$g(z) = \begin{cases} 1, & if\ z \geq \theta \\ -1, & otherwise \end{cases} \qquad (2)$$

In this case, the activation function helps to identify pupil's psychological condition. The pupil who successfully passed the psychological test is allowed to register on the platform. when a pupil registers, the pupil inputs personal information into the platform.

Perceptron is simple form of ANN in Fig 6. Unlike Perceptron,can classified more than two classes. ANN is used to determine pupil's knowledge degree from each subject

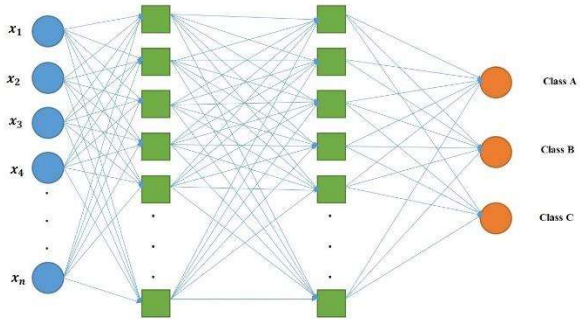

Fig.6. Classification of pupils' knowledge into the classes using ANN

Where $x_i, i = 1..n$ - the number of questions of different complexity for 5^{th} to 11^{th} grades,

Class A- the grade that corresponding to the level of the pupil's knowledge in the chosen subject;

Class B- the module in the selected subject that corresponding to the level of the pupil's knowledge;

Class C- a complexity level of the module;

The educational platform suggests [14] the pupil the grade that the pupil could start studying. Choosing the grade is optional. Afterwards, the pupil can start studying the subjects. Number of subject dependent on the grade. After completing all subjects in the grade, the platform classifies the pupil's knowledge by multi-layer neural network (ANN). ANN classifies the pupil's knowledge depending on the result that the pupil has completed each subject in the grade. As a result, the platform offers the pupil educational materials corresponding to the pupil's knowledge level from each subject. A pupil has to take an exam in the end of each complexity level of task in the module in order to transfer the next level.

Naive Bayes methods are a set of supervised learning algorithms based on applying Bayes' theorem with the "naive" assumption of conditional independence between every pair of features given the value of the class variable. Bayes' theorem states the following relationship, given class variable y and dependent feature vector x_1 through x_n.

A pupil's score is determined using the Naïve Bayes classification machine learning algorithm which expressed in Formula (3).

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \qquad (3)$$

Where:

P(A) is the prior probability of class that reflects background knowledge due to the chance of A to be correct.

P(B) is the probability of B to be observed.

P(B|A) is the probability of observing B given a world in A holds.

P(A|B) is the posterior probability of class (target) given predictor (attribute).

$$P(y|x_1, \ldots, x_n) = \frac{P(y)P(x_1, \ldots, x_n|y)}{P(x_1, \ldots, x_n)}, \qquad (4)$$

Using the Naïve Conditional Hypothesis

$$P(x_i|y, x_1, \ldots x_{n-1}, x_{i+1}, \ldots, x_n) = P(x_i|y), \qquad (5)$$

for each i, this relation simplifies to (6).

$$P(y|x_1, \dots, x_n) = \frac{P(y)\prod_{i=1}^{n} P(x_i|y)}{P(x_1, \dots, x_n)}. \qquad (6)$$

$P(x_1, \dots, x_n)$ is constant given the input values, we can use the following classification rule:
And since the denominator remains constant for all values, the posterior probability can be (7):

$$P(y|x_1, x_2, \dots, x_n) \propto P(y)\prod_{i=1}^{n} P(x_i|y). \qquad (7)$$

Naive Bayes classifier combines this model with a decision rule. One of the general [13] rules is to choose the most likely high hypothesis as in formula (8);

$$y = argmax_y P(y)\prod_{i=1}^{n} P(x_i|y). \qquad (8)$$

and we can use Maximum A Posteriori (MAP) estimation to estimate $P(y)$ and $P(x_i|y)$; the former is then the relative frequency of class y in the training set.
The value of **P(A|B)** could be poor, average, good, excellent. The result of exam classifies by naïve Bayes [12] machine learning algorithm. In this case, naïve Bayes classifies into four classes: namely: poor, average, good and excellent.

Depending on the result of decision tree algorithm [15], the pupil can be transferred the next level (level, module, grade).

If the pupil's score equals to class poor, the platform returns the pupil the previous level. If the pupil's score equals to class average, the platform gives a chance the pupil to study this level again. Otherwise, the pupil can be transferred the next level (Figure 7). After completing each level, the pupil can be transferred the next module (Figure 8).
All modules in the subject must be completed in order for the pupil to finish the subject.
The pupil can be completed each subject in the grade, the platform could be allowed the pupil to transfer the next grade. Thus, in the end of grade 11, the platform determines the pupil's total score. According to the total score, the platform gives the certificate to the pupil (Figure 9).

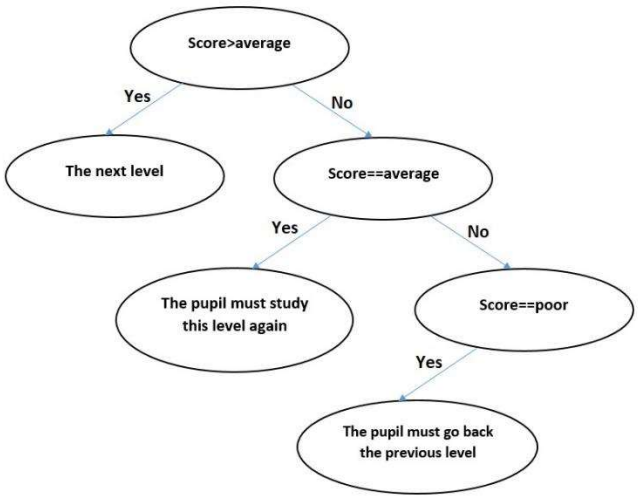

Fig. 7. Determining pupils' level using Decision tree algorithm

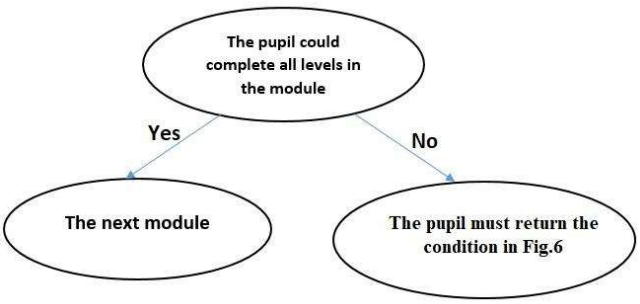

Fig. 8. Determining that whether pupil can pass the next module using Decision tree algorithm

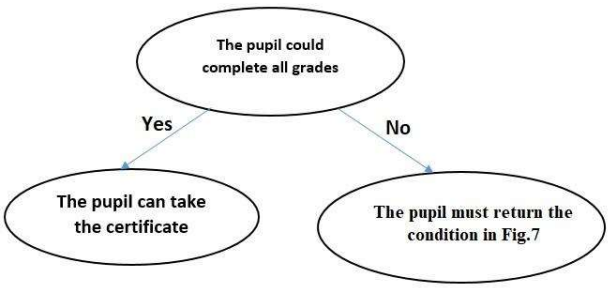

Fig. 9. Determining that whether pupil can finish the school using Decision tree algorithm

IV. USE CASES

Difference of the platform from other educational platforms, the platform is based on machine learning algorithms that is subpart of AI. In other words, the platform is one of the first examples in the new era of educational platforms that is based on AI.

Applying AI in education gives us the following opportunities. The main difference between this platform and others is that the prediction and classification of pupils' knowledge is based on artificial intelligence [17]. The platform can give the pupil following advantages:

- A pupil can study subjects on the platform in a convenient place and at the right time;
- A pupil is allowed to restudy the subjects on the platform;
- The platform concerns individually for each pupil;
- Each pupil's exam is assessed by a system that based on AI, it helps to determine accuracy a pupil's knowledge.

Using the platform in the following cases could be effective:
1. In the education system of poorest countries
2. Lack of teachers
3. Pandemic period

We will overview above mentioned each case in detail.
First case, due to economic problems, many countries in the world cannot spend enough money for education. Educational buildings, educational materials, tools for education, teachers' salaries are required high costs. The platform can help to solve problems in the cases that spend less money for education.
Second case, there may be a shortage of teachers in all regions of the country. This case is not related to money, as the first case. In this case, the shortage teachers can be replaced by the

platform. Third case, due to the coronavirus that emerged in Wuhan in 2019 [9] and spread around the world to pandemic levels, pupils in many countries around the world have not been able to attend classes at school. As a result, the quality of education in schools has fallen. Using the platform is effective in each case mentioned above.

V. CONCLUSION

In this paper, we overviewed the educational platform based on AI that predict and classify pupils' knowledge. We can conclude about the platform as following: low cost, possibility of reusing educational material, the pupils can study subjects on the platform in a convenient place and at the right time, the pupils are allowed to restudy the subjects on the platform, this platform offers an individual approach to each pupil, a pupil's exam in the end of module or in the end of grade is assessed by the system that based an artificial intelligence.

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