Research Article

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Design of English hierarchical online test system based on machine learning

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Abstract: Large amount of data are exchanged and the internet is turning into twenty-first century Silk Road for data. Machine learning (ML) is the new area for the applications. The artificial intelligence (AI) is the field providing machines with intelligence. In the last decades, more developments have been made in the field of ML and deep learning. The technology and other advanced algorithms are implemented into more computational constrained devices. The online English test system based on ML breaks the shackles of the traditional paper English test and improves the efficiency of the English test. At the same time, it also maintains the fairness of English test and improves the marking speed. In order to realize an online English test system based on ML and facilitate the assessment of students' college English courses, this paper mainly adopts relevant research and design on the main functional modules, key technologies, and functional realization of the online English test. The brand-new powerful teaching software and the online examination system can help schools to conduct more systematic and scientific management. The conclusion shows that as brand-new and powerful teaching software, the online examination system can help schools to conduct more systematic and scientific management.

Keywords: English courses, online examination system, automatic scoring, ML, AI, computational constrained devices

1 Introduction

In every single day, digital revolution is becoming more obvious and becoming internet-connected as everything is going digital [1,2]. The Internet no longer belonged to any specific person and the Internet of Things as number of devices has overpassed the world population. Machine-to-machine interactions are solution for monitoring such a high amount of data [3,4]. For high levels of independence, smart interactions are required in the machines. The artificial intelligence (AI) is the field providing machines with

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intelligence. In the last decades, more developments have been made in the field of machine learning (ML) and deep learning (DL). The computers were not powerful enough to run most of the ML algorithms, so AI field was immersed in a long winter [5–7].

Across a range of applications in power systems, AI approaches have been utilized [8]. Recently, significant research interest has been increasing towards the demand-side response. It is one of the promising approaches for power system to provide demand flexibility [9,10]. To many system operators, Demand Resource (DR) programmers are very important [11,12]. A framework is required by the enhanced function of DR schemes which is able to adjust in a dynamic environment. While learning the preferences of end-use consumers, AI can contribute greatly in the future success of DR schemes. The general block diagram of fuzzy system is shown in Figure 1.

Figure 1: General block diagram of fuzzy system.

With the rapid development of computers, the requirements for work efficiency are getting higher and higher. However, the most traditional paper-based exams no longer meet the current demand for exams. In this traditional exam, not only is it time-consuming, but also wastes a lot of paper and has high cost requirements. And in an examination room, the cheating rate will be very high. In the final marking of the paper, the teacher needs to review a lot of time, and it is easy to be mentally exhausted. This will inadvertently correct some test questions. Moreover, the total score on a test paper also needs to be manually calculated by the teacher. After the paper, such mathematical calculations are easy to make calculation errors, resulting in inconsistencies between the actual scores of the test papers and the scores of the evaluation, resulting in unfairness.

After years of development, the technology of using computers to conduct examinations has gradually matured. These examination systems are a great improvement compared to traditional examinations, but such examination systems are not perfect. They are already very good in terms of examinations. They can only randomly draw questions from the question bank, in terms of drawing questions. The student's test questions may be completely different, losing a certain degree of fairness. In terms of marking papers, only some fixed-answer question types (multi-choice, true/false, fill-in-the-blank) can be judged. For some subjective questions (questions, examinations), it is difficult to make comments and corrections. For such question types, grading is generally done manually. This method does improve the accuracy of subjective questions, but for teachers who evaluate and reform, it is no different from traditional exams, but it is less only part of the question type [13]. Application of various AI research method groups for different DR consumer types is shown in Figure 2.

The traditional examination system solves the evaluation of objective questions on the examination; there is still not much to do on subjective questions. At most, it can only make a vague judgment by comparing the correct reference answers, and the accuracy rate is very low.

Figure 2: Application of various AI research method groups for different DR consumer types.

1.1 Contribution

This paper mainly adopts relevant research and design on the main functional modules, key technologies, and functional realization of the online English test, in order to realize an online English test system based on ML and facilitate the assessment of students' college English courses. The brand-new powerful teaching software and the online examination system can help schools to conduct more systematic and scientific management.

This paper is structured as follows. Details of state-of-the art techniques are discussed in Section 2. Analysis of English hierarchical online test system is detailed in Section 3. Detailed design of English hierarchical online test system is presented in Section 4. Section 5 presents and details the results followed by the conclusion of the complete manuscript in Section 6.

2 Literature review

The English test scoring model evaluates and scores the quality of the test by combining techniques such as computational linguistics, statistics, and natural language processing. The difference between the models in automatic examination scoring is mainly the difference between the feature extraction method and the model itself.

The earliest proposed PEG scoring model uses shallow linguistic features to analyze test texts, such as length features to express the fluency of the test, and does not really involve the test content. Therefore, although the early PEG has a higher score accuracy rate, it is not robust enough. For example, its scores for English tests with longer lengths, shorter sentences, and simple words are always higher. In order to effectively extract the relevant features of the test content, some scholars have introduced topic models during feature extraction. They hope to obtain information about the topic structure of the exam through the topic model. Common topic models include latent semantic analysis and probabilistic latent semantic analysis, and potential Dirichlet's main idea is that the central content expressed in a paragraph depends on some important words in the paragraph. The topic model selects these more important words through a series of calculations and uses the vector as the representation of the test topic. With the development of natural language processing technology, the features extracted from the English test text can basically cover grammar, morphology, and other features that directly reflect the content of the test. However, Hua pointed out in the research that most of the words and grammar are considered when scoring the test. Semantic considerations are extremely limited, so two attributes of semantic coherence and consistency are proposed to enrich the feature extraction of the test. Experimental results show that these two attributes

improve the training effect of the model [14]. Bingcai et al. put forward a new feature for the discourse test. They used the degree of support for the argument based on the argument for automatic scoring of the test. Experiments show that the introduction of this feature greatly improves the scoring accuracy of essays [15]. Fragulis combines string kernel functions and word embeddings to obtain feature vectors representing text and trains an automatic English test scoring model, which is better than some models obtained by DL training at that time [16]. Xiaolei carried out feature extraction based on different levels such as text level and sentence level and combined with neural network (NN) design to realize the automatic scoring model of English test with high accuracy [17]. Lou proposed a classification and hierarchical scoring model, which roughly classifies the text through some features and sends it to a model with different parameters for training according to the paper category. The experimental results show that the experimental results obtained in this way are adjacent. The accuracy rate can reach 92% [18]. Shim et al. conducted research on the scoring of English test based on unsupervised learning. Like most unsupervised learning, when training the model, it is necessary to determine the final text training into several categories. Its realization mainly depends on the similarity between the test texts, and the goal to be classified in the process of each iteration articles will be close to similar articles with a certain weight. The final experimental results show that the adjacent accuracy of unsupervised clustering reaches 94% and the absolute accuracy reaches 52% [19].

A multi-agent system based on wind and photovoltaic power prediction is presented by the author in this paper [20] by utilizing the extreme learning machine algorithm. The real weather data are utilized and tested by the algorithm in the region of Tetouan City in Morocco. The electricity with the main grid is exchanged by the microgrid in the presented algorithm. Therefore, it can buy or sell electricity. To control the amount of power delivered from the main grid is the goal of our multi-agent system. Fuzzy logic control is utilized to manage the flow of energy to address the address uncertainties in the system. The overview of AI methods is provided in this paper and DR applications are utilized which are based on a systematic review of thousands of papers [21]. Classification of papers is done with regards to both the AI/ML algorithm(s) used. AI methods have been used for energy DR and commercial initiatives are presented. The advantages and potential limitations of AI methods are discussed by the author in this paper for different DR tasks. A simplified shipboard DC power distribution system is utilized with Consortium for Electric Reliability Technology Solutions microgrid to validate the distributed optimization [22]. Controlling the command variables input to the converters maintained the energy routing through the branches. Sources are manipulated to their optimal set points by these command variables. With the advancement in technology, numbers of devices are increasing which are connected to the internet [23]. Large amount of data are exchanged and the internet is turning into twenty-first century Silk Road for data. ML is the new area for the applications. In this paper, authors present the optimizations, algorithms, and platforms utilized model implementation into the network. Network's intelligence is decentralized to provide guidelines, taxonomies, concepts, and future directions. A novel framework for home energy management (HEM) is proposed in this paper by the authors which is based on the reinforcement learning to achieve the home-based demand response effectively [24]. A finite Markov decision process formulates the concerned hour-ahead energy consumption scheduling problem. A data-driven method is used to tackle this problem which is NN-based and develops a Q-learning algorithm. The superior performance on cost-effective schedules is achieved for HEM system. A residential house level with multiple home appliances is utilized for simulation purpose. The effectiveness of the proposed technique is analyzed and demonstrated by the test results. The problem of real-time management of Smart Grids is dealt with in this paper [25]. Through a telecommunication system, power system is integrated with the energy management. The proposed algorithm utilized the multi-agent systems to find the best-integrated solution. With the help of an academic microgrid, proposed technique is tested and replicated the results. In this paper [26], a study is attempted by the author to effectively integrate the RES to power systems by means of sustainable energy solutions. A electricity generation of local available RES is effectively used by a Smart Adaptive Switching Module (SASM) architecture. The RES generation is supposed to be curtailed without SASM as demonstrated by the obtained results. The effectiveness of the proposed SASM architecture is demonstrated by the numerical case study for a RES system.

3 Analysis of English hierarchical online test system

3.1 Demand analysis

With the development of social economy, people pay more and more attention to education. The English test is an important part of education. In recent years, with the continuous increase in the types of English tests and the continuous improvement of English test requirements, the traditional English test method requires teachers to print test papers, invigilate the test, and approve the test papers, so that the teacher's workload is bigger, and because these links are all done manually, it is very easy to make mistakes. Therefore, many schools or examination institutions have established ML online examination websites to reduce management costs and human and material resources, and at the same time, provide examinees with more comprehensive and flexible services. Candidates hope to make an objective and scientific evaluation of their own learning situation; academic staff hope to effectively improve the existing test mode and improve the efficiency of English test. In order to meet the requirements of candidates and academic staff, the online English test system of ML should include functions such as online test and score query to meet the needs of users.

3.2 Feasibility study

The purpose of feasibility analysis is to determine whether the problem can be solved in the shortest possible time with the least cost. By analyzing the pros and cons of the solution, we can determine whether the goal and scale of the system are realistic, and whether the benefits after the completion of the system are worthy of investing in the development of the system. The feasibility of the online English test system can be considered from the following aspects.

3.2.1 Economic feasibility

Regularly organizing exams is an effective way for colleges and universities to learn about students' academic performance in time. Using ML online English test systems can save human resources and reduce English test costs; on the other hand, ML English test systems can be quick. The examination and scoring of the English test reflect the appearance and fairness of the English test.

3.2.2 Technical feasibility

It includes development of a ML online English test system. The core technical problem involved is how to display the English test time and remaining test time in real time without refreshing the page and achieve the function of automatically submitting test papers when the end of the English test is reached. It would be more troublesome to implement these functions before the emergence of Ajax technology, but now these functions can be easily implemented through Ajax technology, which provides technical guarantee for the development of ML online English examination system [27–29].

3.3 System goals

According to the previous needs analysis and user needs, the ML online English test system is small and medium-sized software. After the system is implemented, the following goals should be achieved:

- (a) Spatial. Authorized users can log in to the online English test system of ML in a remote place without having to go to a designated place to take the test.
- (b) The operation is simple and convenient, and the interface is simple and beautiful.
- (c) The system provides a countdown function of English test time, so that candidates can know the remaining time of the test in real time.
- (d) Randomly select test questions.
- (e) Realize the function of automatically submitting test papers. When the English test time reaches the specified time, if the examinee has not submitted the test paper, the system will automatically hand in the paper to ensure that the test is carried out in a serious and fair manner.
- (f) The system automatically marks papers to ensure that the results are true and accurate.
- (g) Candidates can check test results.

3.4 System function structure

According to the characteristics of the online English test system of ML, it can be divided into two parts: the foreground and the background for design. The front desk is mainly used to register and log in to the system, online exams and check scores and modify personal data; the back-end is mainly used by the administrator to manage candidate information, course information, test question information, and candidate score information. The front-end function of the ML online English test system is shown in Figure 3.

The foreground function of the online examination system based on ML is shown in Figure 4.

Figure 3: The front-end functional structure of the ML online examination system.

4 Detailed design of English hierarchical online test

4.1 Candidate information module design

The candidate information block mainly includes four functions: exam registration, candidate login, modification of personal information, and password retrieval. Candidates must first register as a website user, and then they can be authorized to log in to the website to perform a series of operations; after logging in, candidates can also modify their personal registration information. If candidates forget their login

Figure 4: The back-end functional structure of the online examination system based on ML.

password, they can also quickly retrieve the password through the password retrieval function provided on the website. The system flowchart of the candidate information module is shown in Figure 5.

4.2 Online exam module design

The main function of the online exam module is to allow candidates to take an exam for a specified course on the website. In this module, candidates first need to read the exam rules. After the same listed exam rules, they can choose the exam. After selecting the exam course, the system will randomly select the test questions and then enter the exam page to answer the questions. When the candidate submits the test paper or when the end of the test is reached, the system will automatically score the test paper submitted by the test taker and give the final test score [30–32]. The system flowchart of the online examination module is shown in Figure 6.

4.2.1 Technical analysis of online exam module

Since this system uses the Struts framework, when implementing the online exam module, it is necessary to write the Action Form and Action classes corresponding to the online exam module. The following will introduce in detail how to write the Action Form and Action classes of the online exam module.

Figure 5: System flow chart of candidate information module.

Figure 6: System flow chart of online examination module.

4.2.1.1 Action form class for writing online exam modules

The data tables involved in the online exam module are tb_Lesson (course information table), tb_Questions (exam question information table), and tb_stuResult (examination result table). Through these three data tables, the corresponding ActionForm class can be created, which can be used in their respective modules created in.

4.2.1.2 Create action class of online exam module

The action implementation class student of online examination module inherits the action class. In this class, we need to instantiate the startexamdao class of the online examination module in the construction method of this class. The main method of action implementation class is execute (), which will be automatically executed.

This method itself has no specific transaction. It executes the corresponding method according to the action parameter value obtained by the getparameter () method of HttpServletRequest. The key code of action implementation class of online examination module is as follows:

```

Public class StartExam extends Action{
...the code to declare and instantiate the startexamdao class is omitted here

Public ActionForward execute(ActionMapping mapping,ActionForm
    form,HttpServletRequest request,HttpServletResponse response){

String action = request. Getparameter ("action"); get the value of action parameter
if("startExam.equals(action)){

    Return startExam(mapping,form,request,response);
}else if("submitTestPaper".equals(action)){

    Return submitTestPaper(mapping,form,request,response);
}Else if ("showstarttime". Equals (action)) {{display test timing
    Return showStartTime(mapping,form,request,response);
}Else if ("showremainame". Equals (action)) {{displays the exam time
    Return showRemainTime(mapping,form,request,response);
}else{

    Request. SetAttribute ("error", "operation failed!");
    Return mapping.findForward("error");

}

}
...other methods in this class are omitted here, which will be given later in the specific process
}

```

4.2.2 Realization process of selecting examination courses

After the candidates log in to the front page of the ML online English test, click the "online test" hyperlink to enter the test rules page. Click the "agree" button in this page to enter the page of selecting test courses

eagerly. The courses that need to participate in the examination will be displayed in the form of the following list box on the page. If there is no course to be tested, the system will give a prompt dialog box and return to the front page of ML online examination.

In the test rules page, click the “agree” button to access a URL address, which is `managelesson`. Do? Action = `selectlesson`. From the URL state, we can know that the parameter value of the action involved in the selection of examination course page is `selectlesson`. That is, when action = `selectedlesson`, the method `selectlesson()` corresponding to the course of the specified examinee will be called. In this method, first get the admission card number, then call the `query()` method in the `lesson Dao()` class and take the obtained admission number as the parameter of the `query()` method. Finally, according to the size of the list collection returned by the `query()` method, go to the corresponding page. The specific code of `selectedlesson()` is as follows:

```

Private ActionForward selectLesson(ActionMapping mapping,ActionForm form,HttpServletRequest
    requeat,HttpServletResponse response){

    HttpSession session = request.getSession();

    String stu = session. Getattribute (“student”). ToString(); get admission number

    List = lesoondao. Query (stu); query the course list including exam questions, but excluding the
        subjects that have been tested

    if(list.size() < 1){

        Return mapping.findForward(“noneLesson”);

    }else{ request.setAttribute(“lessonList”,list);

        Return mapping.findForward(“selectLesson”);

    }}

```

4.2.3 Randomly select test questions and display the realization process of test questions

After the examinee logs in to the front page of the online online examination, click the “online examination” hyperlink to enter the examination rules. Click the “agree” button in the page to enter the page of selecting examination courses. In this page, select the course to be tested, and click the “OK” button to enter the test preparation page. In this page, click the “start exam” button to close the current window and open a new window to display the test questions [33].

In the test preparation page, click the “start exam” button to call the JavaScript group closing window and open a new window to display the test questions. The specific code is as follows:

```

<html:button property = “button” styleClass = “btn_Grey “value = start exam” onclick = window. Opener =
    null; window. Close(); window. Open (“startexam. Do? Action = startexam”, width = 786, height = 600,
    scrollbars = 1 “,);” > the test is a new type of test

```

4.2.3.1 Randomgetquestion(), a method of randomly selecting test questions

In the `randomgetquestion()` method, first obtain the set question Id of the specified course, then save the obtained set question Id to an array, and obtain a random number according to the number of sets of questions, that is, to save the specified subscript of the set question Id array. Finally, according to the index,

the corresponding set question Id is obtained and returned. The key code of randomgetquestion() method is as follows:

```

Public int randomGetQuestion(int lessonID){
    Int questionsID = 0;
    String sql = "SELECT taoTiID FROM (SELECT distinct lessonID,taoTiID from" + "(SELECT
        lessonId,taoTiID FROM tb_questions GROUP BY taoTiID,lessonID,type)" + "as lessonTaoTi
        GROUP BY lessonID,taoTiID having count(taoTiID) > 1)as temp" + "WHERE lessonID =" +
        lessonID +"";
    ResultSet rs = conn.executeQuery(sql);
    Int i = 0;
    try{
        rs.last();
        Int recordNum = rs.getRow();
        rs.first();
        Int[]id = new int[recordNum];
        do{
            id[i] = rs.getInt(1);
            i++;
        }while(rs.next());
        Int rand = Math.abs(new Random()).nextInt(id.length));
        questionsID = id[rand];
    }catch (Exception ex){
        ex.printStackTrace();
    }
    Return questionsID;}

```

4.2.3.2 How to save the test results when starting the exam startsaveresult ()

In order to prevent the leakage of the test questions, we can save the test information to the examinee's score sheet at the beginning of the examination, and then modify the test result when submitting the test paper. In this way, even if the examinee does not submit the test paper, the next test cannot be conducted again. In the startsaveresult() method, it is necessary to obtain the corresponding course name according to the passed course ID parameter, and then save the admission card number, the course and the scores of single-choice questions (set to 0), and the scores of multiple topics (set to 0) to the information table of the candidates' score sheet. The key code of startsaveresult() is as follows:

```

Public int startSaveResult(StringstudentID,intlessonID){
    String lesson((LessonForm)lessonDAO.query(lessonID).ge + (0)).getName();
    String sql = "TINSERT INTO tb_stuResult
        (stuId,whichLesson,resSingle,resMore)
    values("+ studentID +"," + lesson +",0,0)";
    Int ret = conn.executeUpdate(sql);
    return ret;}

```

4.2.3.3 How to get the test question queryexam ()

The queryexam () method contains two parameters, one is used to specify the ID of the question and the other is used to specify the type of the test question. If the value of the parameter is 0, it means to query the

single-choice question in the specified set of questions; otherwise, it means to query multiple topics [34–37]. When saving the test question to the corresponding ActionForm, the correct character pattern of the character type needs to be divided into an array and then saved to the corresponding attribute [38–41].

5 Result analysis and comparative analysis

In the display test page, click the “hand in” button or when the end time of the test is reached, the system will automatically mark the test paper and feed back the test results to the candidates in the form of dialog box. The skill metrics for the proposed techniques in terms of RMSE and training time are obtained and analyzed. The obtained values of RSME and training time are tabulated in Table 1.

Table 1: Skill metrics for the proposed techniques in terms of RMSE and training time

Skill metrics		Proposed technique
PV power	RMSE	0.095
	Training time	0.923
Wind power	RMSE	0.112
	Training time	0.836

The graphical representation of the obtained skill metrics is presented in Figure 7 for better analysis of the proposed technique performance.

Figure 7: Skill metrics of the proposed technique in terms of RMSE and the training time.

The results in terms of RMSE and training time obtained by the presented technique are also compared with the state-of-the art techniques. Comparison results are tabulated in Table 2.

Table 2: Comparison of the proposed technique with existing techniques

Skill metrics		BP	ELM	Proposed technique
PV power	RMSE	0.8679	0.1054	0.095
	Training time	6.182	1.011	0.923
Wind power	RMSE	0.912	0.1351	0.112
	Training time	7.996	0.904	0.836

In terms of response time, the performance of the existing extreme learning machine (ELM) technique [20] is promising as compared to the feed-forward BP NN. Training time is also simply bypassed in ELM which is still an issue in a feedforward back-propagation (BP) network [20]. Figure 8 presents the skill metrics of the proposed technique and the existing techniques graphically.

Figure 8: Comparative analysis of the skill metrics with the existing techniques.

From the overall test analysis, it is observed that the proposed technique gave better estimation than the existing ELM and BP NN. The ML models reduce internet traffic and improve the system's security which also ensures the system's performance in real time.

6 Conclusion

This paper makes a comparative analysis of the traditional paper-based English test system and the online English test system based on ML and deeply analyzes the online English test system of ML from various aspects. Finally, it comes to the conclusion that the online English test system based on ML breaks the shackles of the traditional paper English test and improves the efficiency of the English test. At the same time, it also maintains the fairness of English test and improves the marking speed. On the other hand, the English online examination system can provide strong online examination support for distance teaching, which can be closely combined with online courses, so as to realize the integrated English examination system. In the network's end, the ML models reduce internet traffic and improve the system's security. It ensures that the system can perform well in real time. In resource-scarce embedded systems, implementation of ML model is challenging which is not thrown-out easily. The research results show that the score of the online test system can reach more than 90%, which is far greater than the traditional paper test evaluation. The conclusion shows that as brand-new and powerful teaching software, the online examination system can help schools to conduct more systematic and scientific management.

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