DATA VISUALIZATION WITH ENHANCED SECURITY FOR ON LINE TESTS

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***Abstract**: Online tests are very popular and made many security assurances. On line tests have not been widely adopted well, but online education is adopted and using all over the world without any security issues. This paper proposes an enhanced security and data visualization for environment mediated by group of cryptography techniques, using remote monitoring and control of ports and input. As well as tutors can monitor several important aspects related to online tests, such as learner behavior and test quality. The approach includes the logging of important data related to learner interaction with the system during the execution of online tests and exploits visualization to highlight information useful to let tutors review and improve the hole assessment process. And this paper also focused on the discovery of behavioral patterns of learns and conceptual relationships among test items.*

1. INTRODUCTION

Testing systems are being widely Adapted in academic environments as well as in combination with other assessment means, providing tutors with powerful tools to submit different types of tests in order to assess learners' knowledge. Among these, multiple-choice tests are extremely popular, since they can be automatically corrected. How- ever, many learners do not welcome this type of test, because often, it does not let them properly express their capacity, due to the characteristics of multiple choice questions of being "closed-ended." Even many examiners doubt about the real effectiveness of structured tests in assessing learners' knowledge, and they wonder whether learners are more conditioned by the question type than by its actual difficulty. In order to teach learners how to improve their performances on structured tests, in the past, several experiments have been carried out to track learners' behavior during tests by using the think out-loud method:

Learners were informed of the experiment and had to speak during the test to explain what they were thinking, while an operator was storing their words using a tape recorder. This technique might be quite invasive, since it requires learners to modify their behavior in order to record the information to analyze [1], [2], [3], [4], [5], which might vanish the experiment goals, since it adds considerable noise in the tracked data. Nevertheless, having the possibility of collecting data about learners' behavior during tests would be an extremely valuable achievement, since it would let tutors exploit many currently available data exploration and knowledge discovery (KDD) strategies to elicit important insights on the testing activities that can be used to teach learners how to improve their performances. How- ever, it would be desirable to devise noninvasive

data collection strategies that do not influence learners' behavior during tests, so as to convey more faithful feedbacks on the testing activities. In this paper, we present a solution enabling the recording of learners' habits during online tests without informing them of the underlying experiment and, consequently, without asking them to modify their behavior, which potentially yields more realistic results. Regarding the exploration of the collected data, several KDD techniques could be used. Classical data mining algorithms aim to automatically recognize patterns in the data in order to convey knowledge [6], [7]. However, classical data mining algorithms become inappropriate in several situations such as in multidimensional data and data not uniformly distributed. One way to overcome these problems is to use proper visual representations of data in order to stimulate user involvement in the mining process. In particular, information visualization can potentially enhance the human capability to detect structures, patterns, and relationships between data elements while exploring data. Information visualization is defined as the use of interactive visual representation of abstract data to amplify cognition [8]. In the past, information visualization has been successfully used in an e-learning application to measure the participation of the learners to online activities [9]. In this paper, we propose a data exploration approach exploiting information visualization in order to involve tutors in a visual data mining process aiming to detect structures, patterns, and relations between data, which can potentially reveal previously unknown knowledge inherent in tests, such as the test strategies used by the learners, correlations among different questions, and many other aspects, including their impact on the final score.

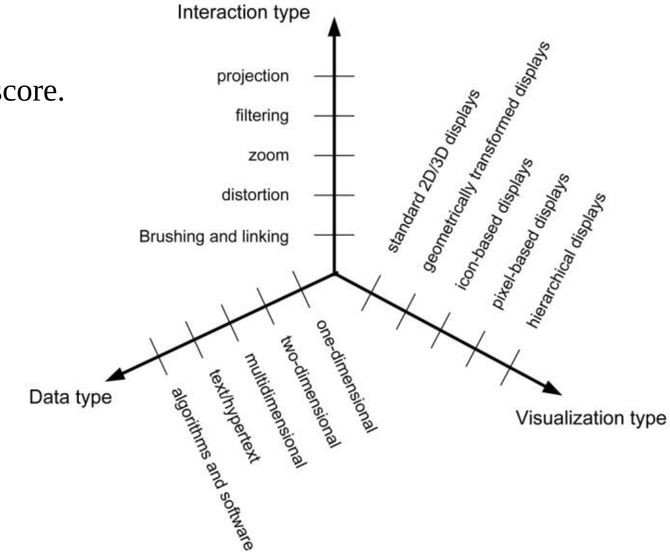

Fig.1. Three-dimensional visualization space

2. INFORMATION VISUALIZATION FOR KNOWLEDGE DISCOVERY

In the last decade, the database community has devoted particular efforts to the extraction of knowledge from data. One of the main approaches for knowledge extraction is data mining, which applies automatic algorithms to recognize patterns in huge data collections [6], [7], [13]. Alternatively, visual data mining presents data in a visual form to stimulate user interaction in the pattern detection process. A combination of visual and automatic data mining draws together human cognitive skills and computer efficiency, which permits faster and more efficient KDD.

Since in this paper, we are interested in a knowledge extraction process in which the tutor plays a central role, in what follows, we will briefly review the basic concepts underlying data visualization and visual data mining

2.1 Data Visualization

As opposed to textual or verbal communication of information, data visualization provides a graphical representation of data, documents, and structures, which turns out to be useful for various purposes. Data visualization provides an overview of complex and large data sets, shows a summary of the data, and helps humans in the identification of possible patterns and structures in the data. Thus, the goal of data visualization is to simplify the representation of a given data set, minimizing the loss of information [13], [14]. Visualization methods can be either geometric or symbolic. In a geometric visualization, data are represented by using lines, surfaces, or volumes and are usually obtained from a physical model or as a result of a simulation or a generic computation. Symbolic visualization represents non-numeric data using pixels, icons, arrays, or graphs. A general classification of visualization methods is presented in [15] and [16]. It constructs a 3D visualization space by classifying the visualization methods according to three orthogonal criteria, the data type, the type of the visualization technique, and the interaction methods, as shown in Fig. 1. Examples of 2D/3D displays are line graphs and isosurfaces, histograms, kernel plots, box-and-whiskers plots, scatter plots, contour plots, and pie charts [6], [13], [17]. The scatterplot matrix, the permutation matrix, and its closely related survey plot are all examples of geometrically transformed visualization methods [18]. One of the most commonly used icon-based visualization method is star icons [13], [17]. However, another well-known method falling into this category is Chernoff faces [18], [19]. An example of the pixel-based display method is recursive pattern visualization, which is based on a recursive arrangement of pixels [20]. Finally, examples of hierarchical visualization methods include dendrograms, structure based brushes, Magic Eye View, treemaps, sunburst, and H-BLOB [21].

2.2Visual Data Mining

The process of visual data mining can be seen as a hypothesis generating process: the user generates a hypothesis about relationships and patterns in the data [13], [20]. Visual data mining has several advantages over the automatic data mining methods. It leads to a faster result with a higher degree of human confidence in the findings, because it is intuitive and requires less understanding of complex mathematical and computational background than automatic data mining. It is effective when little is known about the data and the exploration goals are vague, since these can be adjusted during the exploration process. Visual mining can provide a qualitative overview of the data and allow unexpectedly detected phenomena to be pointed out and explored using further quantitative analysis [22].

The visual data mining process starts by forming the criteria about which visualizations to choose and which attributes to display. These criteria are formulated according to the exploration task. The user recognizes patterns in open visualizations and selects a subset of items s/he is interested in. The result of this selection is a restriction of the search space, which may show new patterns to the user, some of which s/he might not have been aware of before. The whole process can then be repeated on the selected subset of data items. Alternatively, new visualizations can be added. The process continues until the user is satisfied with the result, which represents a solution to her/his initial problem. The user has full control over the exploration by interacting with the visualizations [13]. Visual data mining has been used in a number of scientific disciplines. Some recent examples include detecting telephone call frauds by a combination of directed graph drawings and barplots [23], a classifier based on a parallel coordinate plot [24], and a visual mining approach by applying 3D parallel histograms to temporal medical data [25].

2.2 Combining Automatic and Visual Data Mining

The efficient extraction of hidden information requires skilled application of complex algorithms and visualization tools, which must be applied in an intelligent and thoughtful manner based on intermediate results and background knowledge. The whole KDD process is therefore difficult to automate, as it requires high-level intelligence. By merging automatic and visual mining, the flexibility, creativity, and knowledge of a person are combined with the storage capacity and computational power of the computer. A combination of both automatic and visual mining in one system permits a faster and more effective KDD process [13], [20], [26], [27], [28], [29], [30], [31], [32].

3.The Approach of Data visualization

In this section, we describe the approach to discover knowledge related to learner activities during online tests, which can be used by tutors to produce new test strategies. In particular, we have devised a new symbolic data visualization strategy, which is used within a KDD process to graphically highlight behavioral patterns and other previously unknown aspects related to the learners' activity in online tests

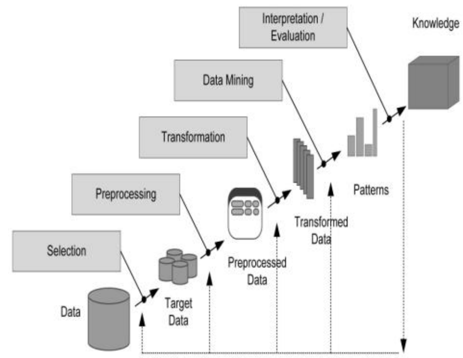

Fig. 2. The steps of a KDD process

4. Related Work on the Use of Data Visualization in E-Learning

The data gathered in years of use of e-learning systems contain knowledge that can provide precious information for improving the approach to online educational methodologies. To this end, several methods and tools for data visualization have been frequently applied to e-learning in recent years, since they can rapidly convey information to the user. The same information is often incomprehensible if provided in tabular or other formats [9]. Many aspects related to online learning can be rendered in a suitable graphical format. Several works found in the literature are aimed at understanding the learner's behavior through the analysis of the data tracked during learners' activities, such as communication in discussion forums and other tools [9] and accesses to the e-learning system pages, with particular emphasis on the accesses to online lecture material [9] . Some of the above papers have also focused on the data analysis of assessment tools but only in relation to the participation of the learner to the online activities and to the results achieved in online tests. Although it has roused a remarkable interest in the classical forms of learning, the analysis of the learner's behavior during tests has no precedents in the e-learning literature. More aspects of e-learning treated using data visualization techniques include the structure of learning material and the use of 3D animation graphics in educational activities .

Other more ambitious projects, leading to more debatable results, focus on the visualization of the relations among the e-learning system's data. In one case [48], the relations are shown in order to better understand the structure of the system interface.

In another approach, the visualization is generalized to all the aspects related to learning, letting the user choose the data of interest . Another important work focused on the use of Data Visualization in e-learning is the one underlying the CourseVis system [9]. This system analyzes and visualizes data regarding the social, cognitive, and behavioral factors of the learning process. We have considered the evaluation of multiple aspects as an extremely interesting feature, and the example of this work has induced us to analyze both the aspects of learner behavior and test quality in our work. The study proposed by Mochizuki et al. is also noteworthy . In this work, the learners (primary school young learners) visualize a chart in order to understand their level of involvement in the main arguments treated in the discussion forums and modify their behavior accordingly.

For the above reasons, the authors have made the interpretation of the visual metaphor as simple as possible. The interactive visualization of information regarding the activity in the discussion forums is also a concern of the work presented by May et al. [43]. Particular attention in the paper has been devoted to the description of technological aspects such as the integration of the data tracked on the client side with those recorded on the server side and the possibility of instantiating the data logging framework on many e- learning systems, as we have done in our work too. The technique of tracking client-side events has also been employed by Hardy et al. [45], in reference to the paths followed by the learners in the browsing of learning material. Typical data gathered in this activity are the frequency and the duration of the accesses to online material. Another activity performed by the authors is the analysis of the correlation between the behavioral data and the results achieved in the exams. The same thing has been done in our work. Nevertheless, while the learner's behavior during test execution seems to be correlated to the final score of the tests, the authors have not found any interesting result about the correlation of the data on the browsing of courseware material with the score achieved on the final exam of the course.

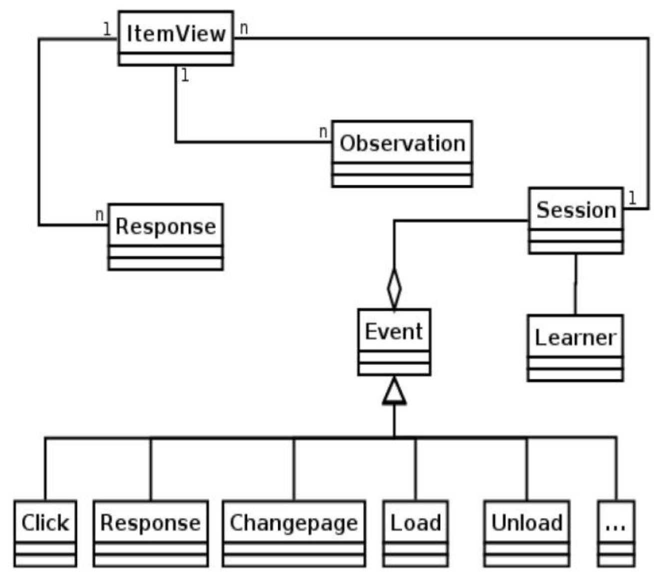

Fig. 3 . Conceptual schema of the data collected during a test session.

4.1 .Enhanced security for on line tests

The cryptography supports enhanced security control for the online exam process, as well as authentication and integrity. The e-monitoring provides a proctor function to remote examinees to prevent cheating, and thus removes the requirement of having to go to a fixed location. The target of this paper is online exams for mathematics or English contests in middle or high school, and exams in online university courses with students at remote locations. This paper addresses the problem of administering an online exam at a fixed time with the same questions for all Examinees, just like an off-line exam, but without restricting the physical location of the examinees. As the **Secure on line test (SOT)** system enables many kinds of tests to be given online, it can provide teachers with better evaluation standards for students and may contribute to improving the quality of education previous work on guaranteeing the security of online exams, as well as current applications of the online exam in distance learning. Section III analyzes the requirements for a secure online exam. Section IV describes the system architecture and the management of enhanced secure online exams system using (SOT) . SectionV demonstrates the soundness of the proposed scheme by analyzing the scheme for preventing and detecting cheating, the security settings, and the overhead (SOT). Conclusions and areas of future research are presented in Section VI.

II. Related work - Enhanced security of Secure on line test (SOT)

One proposal for secure online exams [41] was based on a secure exam protocol with an omnipotent central manager who controlled all the information for students, teachers, problem sheets, answer sheets, and grades. The weakness of this system was that the manager was assumed to be absolutely honest. Moreover, a restricted room was required for the exam, to pre- vent cheating.

Thus, the proposed exam scheme did not share the advantages of online education. The security problems related to online exams include not only unauthorized access to the problem sheets before the exams, but also modification of the questions, the answers, and the grades [41]. In addition, different cheating patterns exist [44,45], including copying the answers of others, exchanging answers, searching the Internet for answers, using the data and software saved on the student's local computer [46], and discussing the exam by e-mail, phone, or instant messaging.

Several methods of combating this include giving a different problem set to each student [43, 45], restricting the exam room [46], [48], or limiting the number of answer submissions to one [46]. Research has focused on methods to check student identities and to communicate securely between teachers and students [41, 47], rather than on countermeasures against cheating on online exams.

Cheating on off-line exams is also a big problem. According to some studies [42, 49], as the level of communication between teachers and students decreases, the tendency to cheat increases.

This effect has a direct impact on online exams, when students may have little contact with their teachers. Most modern online education usesWeb-based commercial course management software such as WebCT [46], Black- board [45], or software developed in-house. This software is not used widely for online exams, due to security vulnerabilities, and the system must rely on students' honesty or their having an honor code. PreviousWeb-based approaches to online exams have high- lighted easy accessibility and simplified exam management [43, 44, 47, 48]. However, authentication through only a user name and password can be the weak point in the security of online exams. The very environment in which students can use a Web browser and the Internet enables them to search the Internet and to communicate with others for help during the exam. One proposal was to use a Webcam to prevent cheating by randomly transmitting pictures of students during online exams [44]. However, several soundless pictures of a student do not show what that student is doing or why he or she is doing it, or even if cheating is taking place through Web searching, the use of saved data, or chatting. Considerable discussion has taken place on group protocols and group-mediated communications to ensure secure communications among group members [50, 51]. This discussion has included the consideration of secure group composition, secure inter group communication using a public key, and secure intra group communication using the symmetric key through the Diffie-Hellman key exchange [52]. This paper adopts two groups for secure communication between distributed entities in the online exam system. The inter group communication is protected through public key infrastructure (PKI),while intra group communication uses several symmetric Diffie-Hellman keys. The "group" in this paper is a concept for entities with similar roles.

III. Requirements for a secure online Test(exam)

The requirements for a secure online exam are as follows.

- Accessibility Online exams should be possible without regard to location and time.
- Monitoring The absence of proctoring on online exams may relax [42, 49] the examinees and encourage cheating [44]. Therefore, it is necessary for an online exam management system to have some monitoring method to prevent and to detect cheating.
- Management Online exam management includes problem creation, problem sheet distribution, answer sheet collection, marking, grade posting, and handling of appeals. The cost savings of online exams mitigate the burden of exam enforcement and induce many examinees located at very remote sites to participate in the exam. Educators can obtain more objective standards for evaluation. The automatic management of exams lets the examinees know their exam performance very quickly. Online exams permit both educators and examinees to achieve their objectives efficiently. An online exam should also have the following features

1. Authenticity

The identities of the examinee, examiner, marker, and proctor should be all authenticated at every step in the online exam process, because it is difficult to identify them "face-to-face" online.

2. Integrity

Problems and answers should both be checked for their integrity, to detect unauthorized changes. Only one submission of the answer sheet should be allowed, and the submission of answers after the exam has ended should be prohibited. The unauthorized deletion or the modification of the materials related to the exam should be impossible, or at least detectable.

3. Secrecy

The problem sets should be available to the examinees only during the exam period. The answer sheets should be kept securely before grading.

4.Copy Prevention and Detection Types of cheating discussed in this paper are

— getting help from others, or helping an examinee with the exam;

— using unauthorized electronic material that may be helpful in completing the exam;

— intercepting or interfering with communications during an online exam.

---impersonating an examinee

— discussing the exam with others;

IV. An enhanced security control in the SOT system

A. Architecture of the **SOT** system As shown in Fig. 1, all entities in the **SOT** system perform their roles as members of either group GA or GE. SS receives the problems and the right answers from CT, and then distributes the problems and collects the answer sheets from CE.. A proctor monitors the examinees through CP using the monitor data in SM. Through CE, an examinee belonging to GE and managed by AE, can take the online exam. The group agents AA and AE create a set of public and private keys [53] for each group. They distribute this set of keys to their group members at each exam, and exchange the public keys with each other. The public key of each group is used for secure intergroup communications. For secure communications among group members, they use the symmetric keys created by the Diffie-Hellman key exchange.

B. Equipment The examinees' computers should be equipped with Webcams and microphones. High-quality Webcams are readily available now and are constantly improving. Therefore, the use of Webcams in online exams is not considered unreasonable.

C. The SOT system software

The **SOT** system software is divided into two parts depending on the role, that is, whether it is on the client side, or server side. The operating system of the examinees' computers and the proctor's computer is assumed to be Windows XP or Windows 2000. However, the program semantics are not confined to Windows because the APIs to control the examinee's computer and to handle the multimedia data are also available in Linux and UNIX environments.

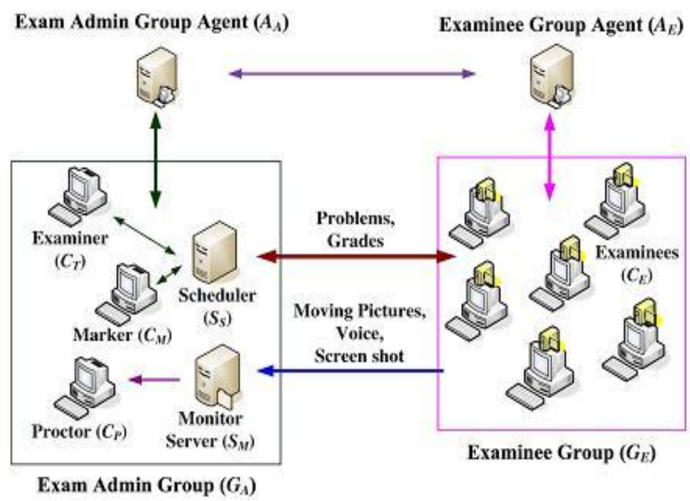

Fig.4:The architecture of **SOT** system

D. Enhances security handling for the online exam process

When the exam environment is set, CT registers toAA and receives its temporary identity T(i). When an examinee registers with AE through CE, he receives its temporary identity T(i) and its IP(Si). CE connects to the scheduler and requests its authentication. After CE registers withAE,AE sends the identities and the IP addresses of the examinee machines. When SS receives the IP from CE, SS notifies the monitor server to verify whether the IP of the examinee is valid or not. If the IP is valid, the monitor server requests the transmission tests of the monitor data for the examinee. When the data stream of video, audio and the screen shots for examinees are transmitted to the monitor server and successfully saved, a proctor inspects them through CP, and decides whether the online exam environment is ready for the examinees.When the online exam is setup, the scheduler sends the problem sheet to the examinee. After receiving the problem sheet CE verifies whether the problem sheet was sent from the authorized scheduler or not. If it is the authorized one, CE sends "ready" message to the scheduler.

If the scheduler receives "ready" message from all the examinee clients, it sends "start" message to all the examinees to start the online exam. The monitor data for all examinees are transmitted to the monitor server until the exam ends. By checking the states of the examinee machines, the scheduler manages the state of the online exam to detect abnormal situations such as faults in state transition. After completion of the exam, CE sends the answer sheets to the scheduler server.

Then the scheduler marks the answer sheet with the right answers provided by the examiner and gives the grade. If subjective questions occur in the problems, the final grade is decided by the marker CM .The grades are distributed to the examinees. If the examinee is not satisfied with his grade, he can submit an appeal to the scheduler. When the marker checks the appeal and re-grades it and then sends to the examinee.

E. Algorithm for online Test process

1. **Star**t
2. Function Setup_exam_environment ()
3. CE[S (i)] registers with AE
4. AE sends identity of s(i) and IP[s(i)] to AA
5. When CE connects to SS, SS sends identity of s(i) and IP[s(i)] to AA for authentication
6. IF AA authenticates CE[S (i)] THEN SS sends problem e[S (i)] set to the examinee CE[S (i)] along with the identity of CT
   ELSE
   Stop the exam process
   ENDIF
7. CE[S(i)] verifies the integrity of e[S(i)] by sending the identity of the examiner to AE
8. IFAE satisfies with the integrity of e[S(i)] and the examiner
   THEN
   CE sends "ready" message to SS
   ELSE
   Request for the problem set again
   ENDIF
9. IF SS receives ready messages from all the examinees THEN SS sends "start" message to all the examinees CE lets the examinees to see the problem one by one
   ELSE
   halts the online exam.
   ENDIF
10. CE[S(i)] sends answers , problem set and its identity to SS
11. IF CE[S(i)] is authenticated by AA THEN SS saves answers in the database
    ELSE
    Rejects the answers from the examinee

    ENDIF
12. After completion of all the problems/time SS sends "end" message to all the examinees to end the exam.
13. SS marks the answer sheet with the right answers provided by CT
14. SS sends grading to the examinees.
15. IF the examinee is not satisfied his grading then he appeals for re-grading THEN
    GOTO Step 13
    ENDIF
16. **END**

V. Analysis

Through the e-monitoring method proposed, the examinees can be watched, just like in an off-line exam. Any cheating that was not noticed during the exam can be detected through the monitor data saved on the monitor server. The enhanced security for the online exam is controlled through the intergroup communication based on PKI, the intra- group communication using symmetric keys and the temporary identity. The exam administrative group and the examinee group are set for every exam. All the entities related to an exam belong to one of those two groups. Agents for the two groups issue the temporary identities to their group members. Neither they nor the group members themselves know the identities of the other group members.

Furthermore, a group member does not know his or her temporary identity, because it is issued in an encrypted form protected by the public key of the verifier, the other group agent. The identities are exchanged by the group agents. Thus, when a group member receives a message, he requests the verification for the sender from the group agent. In addition, message integrity for problems, answers, and grades is guaranteed through the use of digital signatures. Because temporary identities are used in the online exam, it is very important to confirm the identity of someone who is issued a temporary identity. In this paper, that confirmation is performed via a Webcam. An exam administrator connecting to the agent program verifies the person to be authenticated, using the Webcam. In this process, a reference photograph of the group member is taken and saved in the monitor server for later detection of possible impersonation. The problems are managed by the online exam client after they are issued by the scheduler, but they are not opened before the scheduler sends the message to start the exam.

The message is sent only after the online exam environment has been set up and all the online exam clients send the "ready" message to the scheduler. Therefore, it is possible for all examinees to take the online exam simultaneously. The examiners can prepare one set of problems for each of several exam times so that the examinees can choose the time that suits them best. Through the proctor, she or he can supervise the examinees with the monitor data saved in the monitor server in near real time. The problems, their right answers, and the answer sheets from examinees are managed by the scheduler. The authentication, which traditionally was based only on a user name and password , is strengthened by the group management. This process includes verification by Webcam and issuance of temporary identities for every exam. No entity can know all the information, such as the real identities of the entities or the cryptographic keys in the system.This precaution avoids the potential for system compromise due to the failure of a single entity because of maliciousness or an external attack.

The proposed system adopts five methods to prevent and detect cheating. First, the identities of entities in the system are verified by a Webcam, and the reference photos taken during the verification process are saved for authentication during the exam. Second, the monitor data for the examinees are recorded and saved during exam. With continuous recording of video and audio during the exam rather than isolated images, a proctor can better understand the examinee's situation and reduce the chance of false-positives or negatives in the determination of cheating, even after the exam. Third, through the screen shots saved in parallel with videos of an examinee, a proctor can better determine what the examinee is actually doing with his or her computer.

Fourth, all communications by the examinees, except for those required for the online exam, are disabled through port control .All ports except those required for the online exam are disabled and the ports used can be chosen randomly for each examinee; the ports to be used have only to be sent to the exam administrative group with the IP of the exam client. Therefore, cheating through a fixed port can be rare. Fifth, all other programs except the online exam client are deactivated by controlling the inputs of the examinees. By cutting off electronic communications and disabling other computer programs or inputs on the examinees' computers, the examinees can be prohibited from cheating using their local computer or the Internet.

The communications for an online exam take place mainly before and after the exam time. During the exam, only the monitor data, a few messages to check the exam state, and questions, if any, flow to the server side. Communications before exam time are required to authenticate the entities in the proposed system.

The proposed browser module presents to the user at startup a full-screen application window that encases a browser window. However, no address bar is provided, nor are there any menus, toolbars, buttons, or other controls that would be seen on a generic browser. The application window is locked in full-screen mode and cannot be resized or minimized until the application is terminated. Timing the exam helps lessen the opportunity that students have to utilize inappropriate material. If the exam has no time limit, the temptation to avoid studying and rely instead on looking up answers during the exam would be greater. By providing only forty-five seconds per question, we limit the students' ability to engage in this. We also tend to ask lengthy, application based questions.

A. Intrusion detection

There are many ways to detect intrusion in the active network .One of the popular intrusion detection systems is the pattern matching intrusion detection method. Pattern matching looks for a fixed sequence of bytes within a single packet. To filter traffic inspection, the pattern is also usually associated with a particular service and source or destination port. An example of pattern matching is firing an alarm if the packet is IPv4 and UDP, it has destination port 12570, and it contains the string "india" in the payload. Deep packet inspection is another method to detect intruders. A high performance deep packet inspection engine examines all incoming and outgoing traffic, for protocol deviation, content that signals an attack, or policy violations. The deep packet inspection is used for intrusion detection and prevention, web application protection, and application control.

VI. Conclusion and future work

We have presented an approach and a system to let tutors monitor learners' strategies during online tests. The approach exploits data visualization to draw the data characterizing the learner's test strategy, in order to trigger the tutor's attention and to let him/her discover previously unknown behavioral patterns of the learners and conceptual relationships among test items. In this way, the tutor is provided with a powerful tool that lets him/her review the whole assessment process and evaluate possible improvements. We have extensively used the implemented system experimentally to evaluate online test strategies in the courses of our faculty, in order to assess the whole approach. This lets us discover several relevant patterns regarding the test quality, the characteristics of used strategies, and the impact on the final score. In the future, we would like to devise new visual representations and perform further experiments, possibly in combination with classical data mining algorithms. Moreover, since the approach lends itself to the application to other application fields such as e-commerce, in the future; we would like to evaluate its use in these contexts. Finally, we wish to explore more deeply the problem of cheating detection, which we just treat in broad terms here, since we believe that an approach based on logging and visualization can be promising and effective to this aim. This paper describes how the system provides both a secure online test management and a scheme for the prevention and detection of cheating using e-monitoring.

This paper also targeted towards tests(exams) administered through the Internet at a fixed time with one problem set, but without any restriction on the exam location. A powerful feature of the system is that it can be applied to an exam administered at different times. In this case, the examiner should prepare as many problem sets as there are exam times, in order to prevent cheating during the exam. One overhead cost for this system is in the preparation of the equipment, such as Webcams and microphones, to monitor and to authenticate the entities. Future research will consider the methods to reduce the network over load and to prevent all the cheating methods employed by the personnel.

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