

Online Interactive Home Work Grading System

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ABSTRACT

In recent years, World Wide Web usage for teaching and learning has increased rapidly. At the same time, the traditional paper based grading of home works have also not changed. Recently there have been many researches on automated and intelligent grading. Clearly an online grading system would be a highly desirable addition to the educational tool-kit, particularly if it can provide less costly and more effective outcome.

To facilitate the student and faculties in submitting and grading their home works, a new, interactive and adaptable approach has been implemented. The unique feature of this research is to allow the grader to mark over the assignment submitted and to add comments to it. Common errors committed are recorded and is used to recommend the instructor to review certain topics which corresponds to the high error percentage. The system has been developed by making use of free distribution of software products available for the public. Based upon our experience we offer suggestions for improving the system to make it an adaptive system

Keywords: World Wide Web, N-tier architecture, Web based System, Online grading

1. 1.INTRODUCTION

The World Wide Web is becoming an increasingly popular and effective medium for delivery of instruction [2]. Institutions are providing on-line admission, course registration, tuition payment, and other administrative tasks. Students may also submit assignments and do grade queries and instructors can manage assignments, check class enrollments, submit grades, and monitor student progress over the Internet [3]. In this work, we show how Web technology can be used to develop a software system for automatic management of assignments as well as paperless grading. Traditional grading of such assignments often lacks speed and consistency. This is very true for a large class. An instructor for a large class often

spends most of his/her time and effort in retrieving student assignments, manually grading them on paper. This can be mitigated somewhat with supports from teaching assistants. However, such a solution is expensive and is still limited in scope. In this work, we present a Web based software solution that provides an environment for assignment management and grading them online. The original design of the system used Java technology: Java servlets, Java beans that run on Apache server with Tomcat as servlet container. The original design used Oracle database as back end database engine. Due to the time limit that one cannot try Oracle database free for good, we switched the back end database to MySQL[12]. So, this system was developed using software freely distributed and available to the public [11, 12, 13, 14]. Since the portability of Java technology, the system can run on either popular Microsoft Windows systems or Unix, Linux based systems.

Several Web-based systems have been developed for automatic collection of coursework and online assessment and grading of coursework [5]. Among them, Blackboard, WebCT, ClassNet, and Ecourse are notable [1, 6, 7, 8]. Blackboard [1] provides supports for course management, customizable institution-wide portals, and online learning communities as well as an advanced architecture for Web-based integration of multiple administrative systems. ClassNet [6] provides a set of tools for managing activities such as course creation, enrollment control, test creation and assignments, student submission and automatic grading, discussion forums, chat rooms and e-mail exchange between students and instructors. Ecourse [7] provides educators with a set of tools for course management, outlining assignments, delivering lectures, testing, grading, and interaction among students. WebCT [8] provides an interface for developing presentation materials and many educational tools to facilitate learning, communication, and collaboration. It also provides a set of administrative tools to assist the instructor in managing and improving the course. Among them, Blackboard seems a very popular one. All these systems are aimed to provide a user-friendly interface for students to submit all forms of coursework, and an equally user-friendly interface for tutors to grade their coursework and give immediate

feedback. Some also offer online content management so instructors can use web space to organize his/her course materials online so that they don't have to upload course materials each time when they want to post course documents on the system. In a sense, the instructor uses the online space as their own laptop. This reduces the time to post materials online. It also allows instructors to change materials after they posted on the web. However, none of the systems has any good support for online grading of a document. In this work, we have developed a system that can be used to grade the work online, keep track of the student's progress and produce a group statistics of the overall performance. The original motive is to facilitate computer science faculty to grade homework easily and at the same time to easily manage student's homework and grades. In essence, we integrate the online course content management system and grading system together. Note the interactive system can function as a stand alone system that handles the grading of student's homework.

We organize our paper as follows. In section 2, we give a general overview of web based application system. In section 3, we describe the architectural details of our system. In section 4, we discuss various user interfaces to the system. Finally in sections 5, we discuss our plan on the use of the system and make some concluding remarks for its prospect and further development.

2. WEB BASED APPLICATION SYSTEMS

In general, web based applications may contain N-layers. With each layer has its well defined functionality. We discuss here a system with four layers. They are client layer, presentation layer, business logic layer, and data layer.

The client layer of a web application is implemented as a web browser running on the user's client machine. The main job of this layer is to display data and let the user enter or update data. To build this layer there are two general approaches:

- Static HTML client: As the name indicates the client layer is used only to display and get data all the intelligence is placed in the middle tier. When the user submits the data, all the validation is done in the middle tier and any errors are posted back to the client as a new page. This will create more traffic and is vulnerable to security issues.
- Dynamic HTML client: In this approach the client acts as a gateway to inputs. We could make the HTML page not to allow certain types of inputs. For example, for a phone numbers input we could check if all the inputs are numbers and ensure that the number of digits typed is valid. If any of these are wrong then we could alert the user to re-enter the data. The main advantage of this approach is that, we don't have to communicate with the database every time the user typed wrong information. This will greatly decrease the network traffic. The dumb client approach tends to be more cumbersome for end-users because it must go back-and-forth to the server for the most basic operation. Also, because lists are not built dynamically, it is easier for the user to inadvertently specify invalid combinations of inputs (and only discover the error on submission). The first argument in favor of the dumb client approach is that it tends to work with earlier versions of browsers (including non-mainstream browsers). As long as the browser understands HTML, it

will generally work with the dumb client approach. The second argument in favor of the dumb client approach is that it provides a better separation of business logic (which should be kept in the business logic tier) and presentation (which should be limited to presenting the data). Including Dynamic HTML and JavaScript in the Presentation (so it can run on the client) mixes the tiers.

Presentation layer serves as the middle layer between the client and the data layer. It decodes the data from the client. Typically data entered by the user that involves some process. For example, consider the user name and password entered by the user. Once these data are in the presentation layer, they are compared with the data in the data layer. To do so, presentation layer request the data layer for these fields and checks if they match.

The presentation layer can be built in a number of different tools. In early websites, CGI or Common Gateway Interface programs were used to design the presentation layer. Now for modern websites developers prefer

- The Microsoft solution using Active Server Pages (ASP) .NET OR
- The Java solution using some combination of Servlets and JavaServer Pages (JSP)

These tools help developers in embedding dynamic content inside other static HTML in the webpage. They also provide tools that make it easy to parse a webpage coming back from the client to get the user-entered information.

The presentation layer is usually inside a Web Server (like Microsoft IIS, Apache WebServer, Weblogic, IBM Websphere, etc.) A single web server can be configured to serve more than one website. By changing the configuration file, web server could handle several requests. Usually in a production environment, more than one web servers are connected together to serve a single web site. This is usually referred to as web farms. If one server goes down then another server in the web farm will take care of it. Similarly if the traffic to one server is heavy then the traffic is divided and distributed evenly to all other servers.

Application logic is usually implemented in the business logic layer. Business logic includes:

- Performing all required calculations and validations
- Managing workflow (including keeping track of session data)
- Managing all data access for the presentation tier

Business logic usually implements the data processing involved. The Microsoft solution, where COM objects are built, which uses Visual Basic or C++. Or the Java solution, where Enterprise Java Beans (EJB) are built, which uses Java. The business logic layer is generally implemented inside an Application Server (like Microsoft MTS, Oracle Application Server, IBM Websphere, etc.) The Application Server generally automates a number of services like transactions, security, persistence/connection pooling, messaging and name services. By isolating the business logic from these "house-keeping" activities allowing the developer to focus on building application logic while application server vendors differentiate their products based on manageability, security, reliability, scalability and tools support. For small applications both presentation and business layer are usually combined together.

The data layer is responsible for managing the data. In the most case, a data layer may simply be a modern relational database. However, it may include data access procedures to other data sources like hierarchical databases, legacy flat files, XML files etc. The job of the data layer is to provide the business logic layer with required data when needed and to store data when requested. Data layer does not interact directly with the client layer. This makes the system more stable from the client's data. Since all the data entered should pass through the presentation/business layer, the data entered by client are further screened (parsed) and made sure that the data entering the data layer is the exact data that was expected.

3. WGS ARCHITECTURE

We have developed a Web-based Grading System (WGS) The system has several components including online assignment submission, an interface for students to read, review and assess their assignments, check their graded assignments. WGS is a Web-based application and can interact with the user through a Web browser. Javascript is used for client side validation. Apache Tomcat is used as the web server. Servlet is used for server side programming. MySQL serves as the database backend. Structured Query Language (SQL) is used for composing the queries to access the database. Figure 3.1 shows the three tier architecture used in this system.

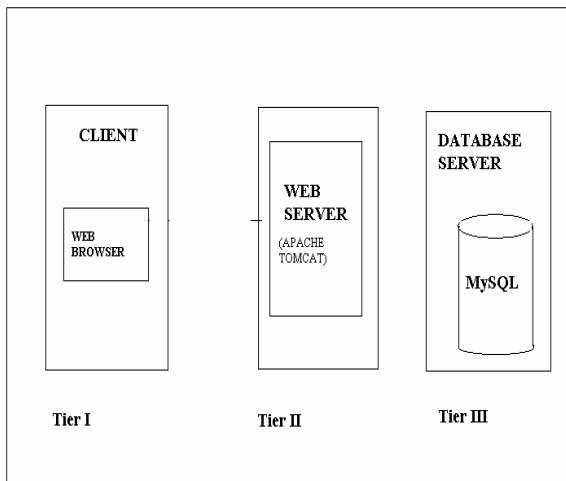


Figure 3.1 Three Tire Architecture

Tier I

This layer is the presentation layer. The user interacts with the server using a web browser such as Internet Explorer or Firefox. JavaScript is used to validate user input. The client requests the web server for HTML page and the server responds to it.

Tier II

Servlet is used for server side programming. Tomcat serves as the servlet container. Dynamic HTML pages are returned to the browser by the servlet. Servlet communicates with the database through JDBC to authenticate the user, store and retrieve data. This tier is also called as application layer.

Tier III

This is also called as Data layer. MySQL is used as the database server. It receives requests from the servlet in the form of SQL queries, executes them and returns the dataset back to the servlet.

JavaScript is used to do validation on the client side. That is, when the client is filling a form, at that time he/she are not allowed to enter invalid data and forces the user to enter data in the required/compulsory fields before submitting the data (to the server).

Servlets are the server side programs written in Java. They reside inside the default directory of Web Server and are executed by the Web Server. The client will interact with HTML page, fill the data and submit it. The Browser will send the data as a request to the Servlet program (the name we have mentioned in the form tag's action attribute) and store the data in the session or in the database as require

The advantages of using servlets can be justified as follows

- Servlets are persistent. Servlet are loaded only once by the Web Server and can maintain services between requests. On the other hand, CGI (Common Gateway Interface) scripts must be loaded and executed by Web Server each time a request is made to it.
- Servlets are fast. They offer better performance since they need to be loaded once.
- Servlets are platform independent as they are written in Java. Because the server available to run the servlet program are actually platform independent and can be installed on any operating system e.g. UNIX, Linux, Windows etc.
- Servlets are extensible. All the benefits of Java can be brought into our Servlet.
- Servlets are Secure. The only way to gain access to a file is through Server. If Server is protected, the Servlet is protected as well.
- Servlets can be used with a variety of client i.e. Browser, applet etc.

Apache Tomcat is the open source servlet container that is used in the official Reference Implementation for the Java Servlet and JavaServer Pages..

- Server Side Include (.shtml) program can be executed by this servlet.
- Servlet chaining can be done.
- Most import point, it always gives you the updated response from the servlet program even if the server is running and you change the servlet program, compile it and copy it in the default directory of the server (i.e. servlets). No need to restart the server.
- It also provides a default directory to copy the html files and provide the security to them.

4. INTERFACE IMPLEMENTAION

WGS has three different users namely Admin, student, Instructor/grader.

Admin

Admin updates students enrolled in a class and assigns Instructor for different courses. Username and passwords are assigned by the admin. Password can be later changed.

Student

Student logs in to submit or to view his assignment. As most of the online systems, student can change password, can re-login in case password did not match the one stored in the database. If the assignment is graded, the graded assignment with comments and grade is available. There are many other pages that interact with students. Among them, Figure 4.1 shows a screen shot of a submitting assignment page. From this page the student can submit their assignments. The student has to select the assignment name from the combo box and have to give the filename by which he/she wants to save the program. The filename should have “.java” extension. Scripting is done to prevent the student from entering invalid file name.



Figure 4.1 Assignment Submitting Screen

Instructor/grader

Some of the program can be set up to grade by the system automatically, while some program such as applets can be graded interactively. For example a program that play computer game. Such kind of programs are unlikely to be graded automatically. In case there are errors in the program submitted. The instructor can view and grade these assignments manually. To grade an assignment, a separate java frame opens. A screen shot of it is shown in Figure 4.2.

Once the grader selects the assignment number, the list of students who have submitted the assignment is shown below. By selecting the student's name his/her assignment loads for grading. The grader can make markings like drawing oval, lines and rectangle to highlight and to improve the style. For every marking, the grader, can either add a comment or create a new error type if it was not created before. For example in the screen shot of Figure 4.2 we can see that Matt Alom's assignment 1 is being graded. At this point there are three errors. Those errors are displayed in the comment area along with the line number. Once the grading is done, it is saved and is ready for the student to view.

Once the assignment is graded, a performance review is given to the Instructor. This statistic data contains the most frequently committed mistakes. It can be set up as a feedback to the instructor to indicate certain concepts or skills need to be reviewed or enhanced to help students' learning. It is great means to improve and make teaching more effectively. By collecting all these grading data over semesters and across different sections, instructors can improve their teachings and expect better teaching quality and results in the long run. This aids the instructor in pedagogy building. If pedagogy component is built into the system, the outcome of the assessment can be used to direct the way of teaching and methods.

5. CONCLUSION AND FUTURE WORK

We designed and developed a new approach to an online homework handling and grading system. The system has been tested and the outcome is satisfactory. The system can easily assist students and college instructors with courses and homework assignment management and grading. It is especially useful for programming courses, such as the introductory courses of computer science. The system is appropriate for programs written in the Java programming language. But can be easily applied to other domains.

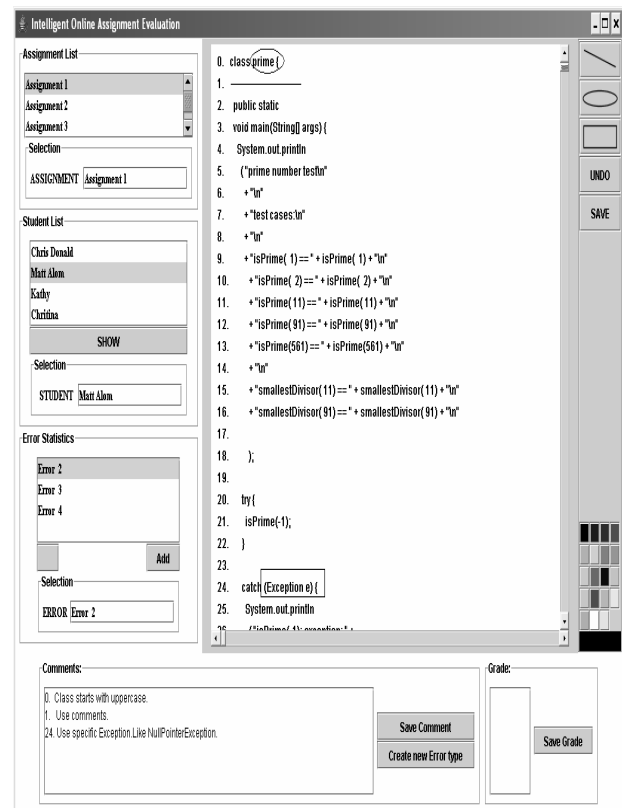


Figure 4.2. Screen Shot of the Grading Frame.

WGS can be easily integrated with an existing course management system as an enhancement. To maintain consistency in grading, automatic-predefined scores can be deducted whenever an error is assigned. To speed up the grading, common errors can be listed based on the frequency of the rate of occurrence for a particular type of programs. The listing allow instructors to select the errors that student committed by pointing to the error lists. As soon as the error comments are selected by pointing, the graders can put those comments on the place that they want to show to the students. This comment information can then be marked on the student's grading result page which can be viewed by the students. New error can be entered by the grader manually provided it is the first time that it appeared. As mentioned earlier, the points to be deducted for different mistakes can be predetermined. But it can also be reset after the whole class was graded. For example, if an instructor decided to change the grading criteria after the grading of whole class is done or even in the middle of the grading It can be achieved without much problem. The

system can recalculate the grading scores easily. It is pretty much like using Microsoft Excel to record the student's grade, but at the time of giving letter grades, the instructor can change the cut-off points for different letter grades. A final remark is that the system can be implemented more efficient if a tablet computer is used by the instructor rather than a computer with mouse based pointing device. For it is easier to pointing to the errors or the places that instructor like to draw students' attention. In the future it is also possible to link certain types of error to certain group of web pages so student can review, practice exercises and re-sharpen on a particular concepts or skills. It will make the system more intelligent. Once again, an online grading system gives convenience to both student and instructor. In light of future e-college, not only video or audio interactions play a major role, but an automatic and interactive online homework grading system may be very helpful to make taking programming course online a practical reality.

6. REFERENCES

- [1] Blackboard Inc, Blackboard products, blackboard.com, 2003
- [2] Laws, R. Distance learning's explosion on the Internet, *Journal of Computing in Higher Education*, 7, (2), 48-64, Spring 1996.
- [3] Johnson, W. L., Blake, T., Shaw, E. Automated management and delivery of distance courseware, Presented at WebNet 96 - San Francisco, CA, October 15-19, 1996.
- [4] MySQL Documentation, www.mysql.com/documentation/2005.
- [5] Joy, M. S., Luck, M. The BOSS system for on-line submission and assessment, *Monitor: Journal of the CTI Center for Computing*, 10, 27-29, 1998.
- [6] Iowa State University Computation Center, ClassNet documentation, classnet.cc.iastate.edu/help/what_is_classnet.html, 1996.
- [7] eCollege.com, eCourse, www.ecollege.com/solutions/Teaching_Course.html, 2002.
- [8] WebCT, WebCT software and services, www.webct.com/products, 2001.
- [9] Abhijeet Trivedi, Dulal C. Kar, Holly Patterson-McNeill "Automatic assignment management and peer evaluation", Consortium for Computing in small colleges., 2003
- [10] J. Jenq and J. Desai, "A prototype On-line Homework Handling System", Proceedings of Eleventh International Conference on Intelligent Systems: Emerging Technologies, 2002, pp 109-113
- [11] Java Development Kits <http://java.sun.com>
- [12] MySQL database www.mysql.com
- [13] Apache Web Server <http://apache.org/>
- [14] Tomcat <http://Apache.org/>