Batch Grading of Excel Homework Assignments

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This is a report of a design project to incorporate automated grading of Excel homework assignments in an engineering economy course. The instructional faculty wished to (1) reduce the amount of time spent on grading and at the same time (2) improve the quality of grading and (3) reduce the lag time in providing feedback of results to students.

A grading system, somewhat unimaginatively named Grader4, has been used for several semesters [1]. Student reaction to the system was generally positive. Since then, additional development work has been done from the standpoint of the instructor's use of the system. This paper is a report on the design project to develop a grading system to be used for batch grading of assignments.

Objectives

The major objectives of the design project were to maximize the instructor homework grading productivity and accuracy. Much of the work has involved improving the usability of the system:

- Optimizing the amount of relevant information provided to the instructor.

- Providing information in an intuitive and naturally understandable manner.

- At the same time, streamlining the information flow so the instructor does not need to deal with details that could be automated.

- Allowing the instructor to personally assign a grade and comment for each student assignment (the system provides information but does not assign grades).

- Allowing the instructor to handle large numbers of homework assignments effectively. Along this line, significant amounts of other work has been done to incorporate computer based problem solving, with the objective of serving more students without degradation of the student learning experience. [2]

- These goals are consistent with published objectives [3] of a similar, commercial grading program: provide practice in problem solution, save class time for more important activities and have students better prepared for class, among others.

To resulting system will be described by reviewing the steps necessary to grade a homework assignment. Design considerations are addressed at appropriate points in the description.
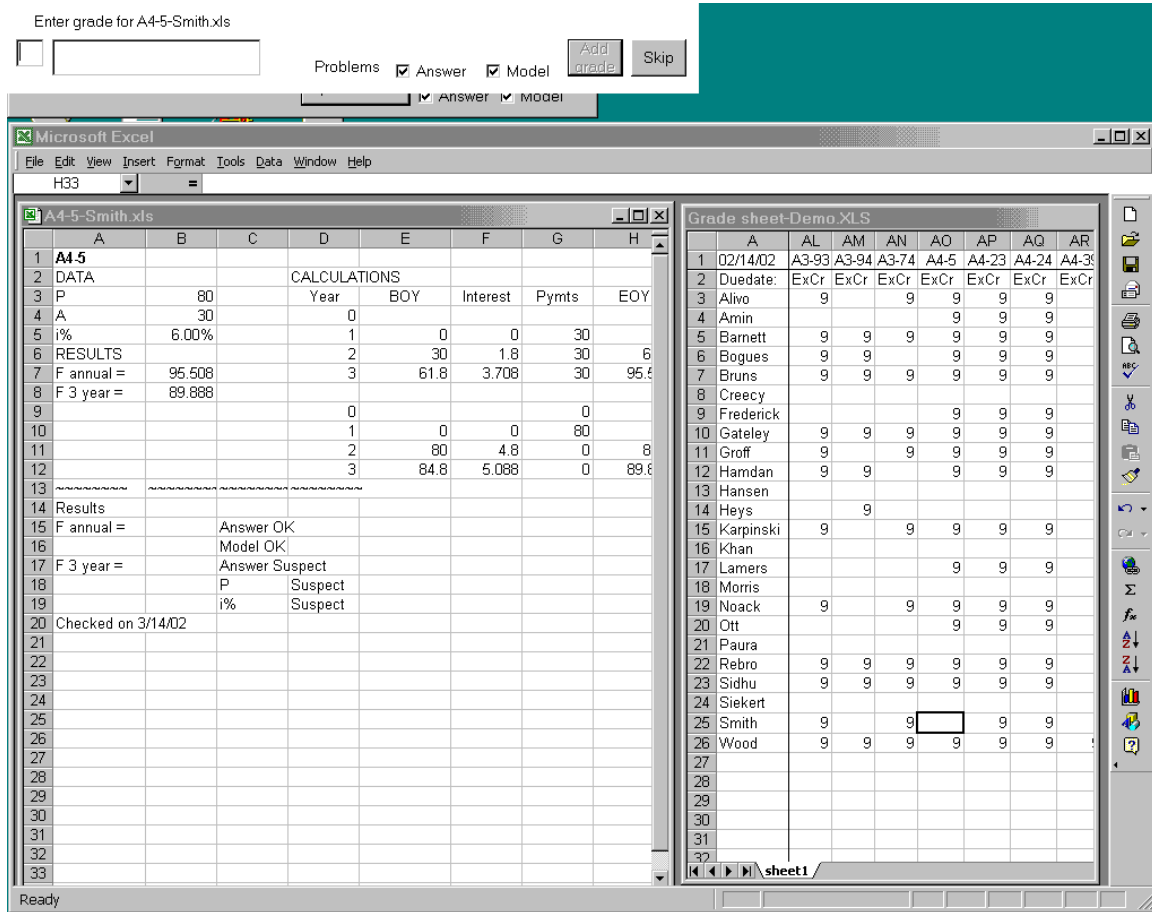
Example

The operation of the Grader4 system will first be illustrated by a simple example. First, the student downloads a data file for an assignment. The problem statement is contained in the course textbook. This analysis requires comparison of the future costs of two ways of paying for a three year magazine subscription, $80 now or $30 at the end of each of three years.

	A	B	C	D
1	A4-5			
2	DATA			
3	P	80		
4	A	30		
5	i%	6.00%		
6	RESULTS			
7	F annual =			
8	F 3 year =			
9				
10				

Second, the student completes the solution in the same file. The students have a great deal of latitude in finishing the spreadsheet. No one particular approach or format is required. This particular student has chosen to make two tables to track virtual accounts that would hold the given amounts of money and compounded interest, one for each option. Other approaches could be used. This file is then submitted for grading. [Note that this spreadsheet contains an error. The $80 three-year fee has been placed at the end of year 1, not year 0.]

A4-5-Smith.xls

	A	B	C	D	E	F	G	H
1	A4-5							
2	DATA			CALCULATIONS				
3	P	80		Year	BOY	Interest	Pymts	EOY
4	A	30		0				0
5	i%	6.00%		1	0	0	30	30
6	RESULTS			2	30	1.8	30	61.8
7	F annual =	95.508		3	61.8	3.708	30	95.508
8	F 3 year =	89.888						
9				0			0	0
10				1	0	0	80	80
11				2	80	4.8	0	84.8
12				3	84.8	5.088	0	89.888

Third, the instructor grades the file.

Enter grade for A4-5-Smith.xls

Problems ☑ Answer ☑ Model [Add grade] [Skip]

☑ Answer ☑ Model

Microsoft Excel

File Edit View Insert Format Tools Data Window Help

H33 =

A4-5-Smith.xls

	A	B	C	D	E	F	G	H
1	**A4-5**							
2	DATA			CALCULATIONS				
3	P	80		Year	BOY	Interest	Pymts	EOY
4	A	30		0				
5	i%	6.00%		1	0	0	30	
6	RESULTS			2	30	1.8	30	6
7	F annual =	95.508		3	61.8	3.708	30	95.5
8	F 3 year =	89.888						
9				0				0
10				1	0	0	80	
11				2	80	4.8	0	8
12				3	84.8	5.088	0	89.8
13	~~~~~~~	~~~~~~~	~~~~~~~	~~~~~~~				
14	Results							
15	F annual =		Answer OK					
16			Model OK					
17	F 3 year =		Answer Suspect					
18			P	Suspect				
19			i%	Suspect				
20	Checked on 3/14/02							

Grade sheet-Demo.XLS

	A	AL	AM	AN	AO	AP	AQ	AR
1	02/14/02	A3-93	A3-94	A3-74	A4-5	A4-23	A4-24	A4-3(
2	Duedate:	ExCr	ExCr	ExCr	ExCr	ExCr	ExCr	ExCr
3	Alivo	9		9		9	9	9
4	Amin				9	9	9	
5	Barnett	9	9	9	9	9	9	
6	Bogues	9	9		9	9	9	
7	Bruns	9	9	9	9	9	9	
8	Creecy							
9	Frederick				9	9	9	
10	Gateley	9	9	9	9	9	9	
11	Groff	9		9	9	9	9	
12	Hamdan	9	9		9	9	9	
13	Hansen							
14	Heys		9					
15	Karpinski	9		9	9	9	9	
16	Khan							
17	Lamers				9	9	9	
18	Morris							
19	Noack	9		9	9	9	9	
20	Ott				9	9	9	
21	Paura							
22	Rebro	9	9	9	9	9	9	
23	Sidhu	9	9	9	9	9	9	
24	Siekert							
25	Smith	9		9		9	9	
26	Wood	9	9	9	9	9	9	!

sheet1

Ready

Grader4 checks both the absolute answer against a key, and also investigates the integrity of the logical model underlying the solution. In this case, Grader4 has determined that both the answer and model for the annual payments are "OK." However, it has detected that the answer and model are "Suspect" for the other plan. The error in the model logic is reported in terms of the data items that appear to be handled improperly. Here, the "P" and "i%" values are both "Suspect." This indicates that the incorrect expression (or series of expressions) use these two data items. Other possible reported errors include "Missing effect" and "Unexpected effect."

Grader4 also presents the class grade sheet for the section (on the right), with the appropriate student and assignment selected. Grader4 also checks for due date and for the assignment already being submitted.

Grader4 does not assign grades. It helps the instructor assign grades, pointing out errors. The instructor enters a grade, along with an optional comment (in the upper left corner of the figure.) The grade is added to the grade sheet and the grade and comment are appended to the student file.

The instructor, in this case, can mark the assignment as wrong and ask that it be resubmitted, or track down the error, using the "Results" section of the above figure as a guide. The student spreadsheet and the grade sheet are both "live" Excel files and can be investigated and manipulated as any Excel file.

Files

Instructors assign homework problems to be solved on Excel spreadsheets. Students download a data file for each spreadsheet; complete the solution and turn in the result. Design objectives

include the ability to turn in assignments remotely. Security is also important; students should expect their files will arrive in a safe and timely manner, and instructors should expect that complete, non-corrupted files be received by the assignment deadline.

The Grader4 system allows students to transfer files to a course account on the university network server. Protections on the directory allow students to list file directories. However, students cannot view any file contents or have any other access to the files. They cannot overwrite files with another file of the same name. Currently, students can turn in files from any university computer connected to the network. These precautions have the impact of requiring that the students be physically present on campus. A future enhancement will allow students to also submit files via e-mail from off-campus locations.

At the beginning of the grading process, the instructor moves all files to be graded from the submission directory to a secure grading directory, generally on a local hard drive. Design objectives require an audit trail; a way to go back and reconstruct grading actions in the future. To accomplish this, files to be graded in each batch session are placed in a separate directory, labeled with the grading date. Assignment submissions and grading actions may be reconstructed, when necessary, from (1) these isolated files, along with (2) the system dates included in each student file, and (3) a grading log file, to be described shortly.

Grading Program

The instructor begins the batch grading process by starting Grader4. One central program directs the flow of information through several spreadsheets windows and a log file. Design objectives call for all pertinent assignment data for a section to be in one location and readily visible on the grading program screen. Further, the homework grade data needs to be in spreadsheet format, to allow the instructor to calculate grades and readily analyze class performance.

To start the batch process, the instructor opens a grade sheet for a group of students in the same section. The grade sheet contains basic information for each student, as well as the problems assigned and their due dates. A grade for each assignment will be entered in a cell of this grade sheet.

Batch Grading

While it is possible to use the grading program to check individual students submissions, only batch grading is reviewed here.

The objectives of the design also emphasize instructor convenience and productivity. After the submitted files have been isolated, all of the instructor's attention can be turned to grading, with little further concern for bookkeeping.

To begin batch grading, the instructor picks the directory that contains all of the files to be graded. Each file in the directory is then analyzed, one at a time, and results presented. Grader4 loads each file, displays error status, asks for a grade (and comment, if desired) and then deals with all of the bookkeeping.

Grader4 is preprogrammed with a number of end-of-chapter problems and solutions. The instructor does not need to modify the program.

Results and Grade

The project design objectives require that the system present the results of student homework file analysis to the instructor in a clear and unambiguous fashion. There are four indicators of assignment status: (1) on time or not, (2) previously graded or not, (3) answer correct or not and (4) model apparently consistent or not.

In the last case, the sources of discrepancies are identified. Part of the evaluation of each student assignment is an investigation of the internal consistency of the spreadsheet model. All is not

possible to detect all possible errors; but the system is able to locate the most common student mistakes. It is able to find errors much more quickly and consistently than a human grader.

Color was chosen as a method of rapidly conveying the status of the student file. A grade and comment panel is presented to the instructor at this point. Checkmark fields and color indicate the status of the current assignment.

The design goals are for the instructor to manually assign all grades and add appropriate comments. Most assignments are normally done satisfactorily. For efficiency, the instructor can rapidly note a green panel that indicates that no problems were encountered with this assignment. The instructor can assign the appropriate maximum grade, and move on to the next assignment file.

Other colors of the grade and comment panel indicate when problems do exist. For improper answers or model construction, the offending cell in the student spreadsheet can be highlighted along with the dependent, referenced cells. This information helps guide the instructor to investigate and identify the problem.

Feedback

The project design goals include providing as much feedback information to the student as possible. To achieve this goal, the instructor assigns a grade based on the status indications provided by the program, and a personal evaluation of the student model. The instructor may also enter a comment for the student. In addition, the instructor may type any additional information desired on the spreadsheet itself. The grading system inserts the grade into the grade sheet, and sends an e-mail to the student with the grade and comment. Students can retrieve the graded spreadsheet. The grade and comment and other information are entered into the grading log file. The instructor can review the batch grading process in any time by investigating the grade log file.

Experience with the System

This grading system has been used successfully for several semesters. It has provided a number of advantages.

- Assignments can be graded more quickly. The instructor estimates that time spent using Grader4 is at least ¼ that of manual grading. Time savings is even more striking when compared to the previous method of manually grading hand-written solutions.

- In particular, it is possible to concentrate on assignments that need attention, and spend little time on those that do not.

- The instructor is less likely to put off grading and delay feedback to the students.

- Grading is more accurate; the system consistently finds errors that the instructor would have overlooked.

- The instructor spends much less time dealing with bookkeeping matters.

- Students have been enthusiastically supportive of the system. In a recent course evaluation of the identical program in a business statistics course, students rated Grader4 as "being helpful," with an average score of 4.75 out of 5. Experience in engineering economy has been similar, however no surveys have yet been taken.

References

1. Stevenson, Dennis R., "Automated Grading of Engineering Economy Assignments," ASEE 2001 Annual Conference

2. Arvan, Lanny, et. al., "The SCALE Efficiency Projects," University of Illinois, http://www.aln.org/alnweb/journal/vol2_issue2/arvan2.htm

3. http://www.unl.edu/pr/2000/0300/030700bnews.html

Biography

Prof. DENNIS R. STEVENSON, P. E. has taught in the engineering department at the University of Wisconsin-Parkside for several years. He previously was design manager for a mechanical engineering consulting firm in Chicago, participating in designs for suture needle manufacturing machine, cheese factory production, long wall coal mining, cotton seed processing (a national award-winning design) and others. Prof. Stevenson develops software for educational education. He has written texts in Engineering Economy and Engineering Graphics, as well.