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# MATLAB Grader<sup>TM</sup> for computational assignments; a way to increase speed and motivation

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## I. INTRODUCTION

During the academic year 2021-2022 we taught the course Numerical Linear Algebra (STÆ511M) at the University of Iceland that involved some computational assignments. We used MATLAB Grader<sup>TM</sup> to assess the students' submissions. This presentation is about how it improved the students' engagement and overall learning.

Officially introduced in July 2018, MATLAB Grader is a service developed by the MathWorks team to help teachers create and share computer assignments (to be more precise, MATLAB-based programming problems) for their courses, and grade students' submissions automatically.

The environment looks like a digital exam sheet with three different sections where the instructor writes a description of the problem in the first section. In the second section there is a window where students write their script/code that runs on MATLAB when they hit *submit*. You will put a **Reference Solution** there as the ideal solution or a possible correct answer that will run against the students code, but they can not see it. However, you can keep some lines of code visible for students as **Learner Template** and provide a skeleton for the script that students are going to complete.

The last section, **Assessment**, belongs to tests which you design to evaluate the student's work. Tests run after the solution submission and will compare values of specified parameters/variables in students' submissions with the **Reference Solution**. You can predict some common errors and provide a feedback or hint

in case the test is failed. That will help the students to solve the issue in the next submission, and move toward the complete score.

## II. PROCEDURE

After logging in, and on the first page of MATLAB Grader, you can find a 13-minute video as a guided tour, and a 2-hour self-paced training for teaching with MATLAB. It is a good idea to have a quick look. Also remember that as an instructor, you will have access to the previously created courses and problem collections. That might be a good place to start from, see some examples and grab few ideas. Let us focus on four different aspects of using MATLAB Grader:

*Run your assignments in any learning environment*  
MATLAB Grader is compatible with numerous learning management systems (LMS). Therefore, you can integrate it into pretty much any learning environment and run your assignments in them. If you do not have your own learning environment, you can use a hosted assessment environment provided by MathWorks.

*Browser-based authoring environment*  
MathWorks cloud solutions (including MATLAB Grader) are compatible with most modern web browsers running on Windows, Mac, Linux, and Chrome OS, but Google Chrome is recommended.

*Type of tests*  
Currently there are four test types in MATLAB Grader:

- *Variable Equals Reference Solution*  
Using the `assessVariableEqual` function, it checks that the value of a specific variable in the student's solution is equal to the one in the Reference solution. You can define several parameters for this function like *Absolute tolerance*, and *Relative tolerance* for er-

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ror precision, or *Feedback* that provides additional feedback to display to the learner.

- *Function or Keyword Is Present/Absent*

Functions `assessFunctionPresence` or `assessFunctionAbsence`, are used to check if specific functions are (or are not) present in the learner solution. Also when you want the students to use (not use) a certain word like an argument or parameter, you can use these type of tests.

- *MATLAB Code*

For more complicated and personalized evaluation, you can create your own test code/function.

*Use custom scoring rubrics and learning analytics*

You have two options for the evaluation of tests: choose a binary correct/incorrect system or weighted grading. Further, you can view a complete history of students' attempts to find the correct solution.

### III. RESULTS

While it is always hard (and sometimes boring) to grade all the assignments on time and with details, students need feedback during the semester to see what their mistakes are and how to avoid them later. You can check all the details and steps of their programs, provide helpful feedback for common errors and just do it once.

The fact that students run their submitted solutions and get grades in real time, combined with clever contextual hints you can put here and there makes the progress you wish to happen more probable and the whole exercise becomes an interactive learning experience.

### IV. DISCUSSION

When you link your LMS course with MATLAB Grader, problems from that course become available for re-use. That can save you enormous time if you

teach a specific course repetitively. Our personal experience in accessing MATLAB Grader through Canvas was not flawless, for example, due to privacy policy and sharing data with third party, student names were encrypted in MATLAB Grader, so we could not use learning analytic tools effectively. The students submissions were not visible on the hosted version (on Mathworks website) and were only accessible in Canvas under Grades/Reports.

The support for using MATLAB Grader were first class and the documentation is very good.

We think the most important part of using MATLAB Grader successfully is related to how well you can create your tests, so we will provide some info and tips about **Assessment** section in the rest of this short review.

- For running your code, MATLAB is automatically included behind the interface so you can use any functions available in the latest version of MATLAB. However, you need to add any toolboxes that you use. Otherwise, students will get an “undefined function or variable” error.
- Usually, if there is a small error in some steps, the error will affect the whole answer. In such cases, it is good to check the box “Only show feedback for initial error” in the **Assessment** section so that the students can focus on it before proceeding. You can also use the Pretest option so that students can check some errors before submitting their solutions.
- A simple yet effective trick that stops the students from copying final values from each other is randomization. You could provide students with a small random value (which will vary for different students) but it will be consistent between the **Reference Solution** and the **Learner Template** since MATLAB Grader shares the same seed for random numbers between the two solutions.