

Generating Multiple Random Exams Using Mathematica Package and L^AT_EX

E. Gómez-Déniz

Department of Quantitative Methods
and TIDES Institute
Univ. of Las Palmas de Gran Canaria
Email: emilio.gomez-deniz@ulpgc.es

N. Dávila Cárdenes

Department of Quantitative Methods
and TIDES Institute
Univ. of Las Palmas de Gran Canaria
Email: nancy.davila@ulpgc.es

M.D. García Artiles

Department of Quantitative Methods
Univ. of Las Palmas de Gran Canaria
Email: mariadolores.gartiles@ulpgc.es

Abstract—In the framework of the European Higher Education Area, the assessment has been one of the most important aspects considered. In the Spanish Universities, one of the main differences with regard to the previous system is the incorporation of the continuous assessment to the evaluation process that is understood in several ways depending on the Universities, the courses and the lecturers. Focus on our context, a course of Mathematics of the first academic year in the Faculty of Business Administration at the University of Las Palmas de Gran Canaria (Spain), the continuous assessment has brought the preparation of a large amount of different tests to evaluate the students enrolled in it, therefore the incorporation of new tools and skills in order to make the teaching–learning process easier and more dynamic has become a need mainly in those degrees with a large number of students as the case we consider here. In this work we provide an efficient and effective way to elaborate random multiple-choice examination tests (although essay exams are also possible) by using *Mathematica* package and L^AT_EX in order to make easier to the lectures the preparation of a large number of mid-term tests for a large number of students.

Index Terms—Exam, L^AT_EX, Mathematica, Random, Test

I. INTRODUCTION

The teaching–learning process has become a dynamic process after the implementation of the European Higher Education Area that has brought the continuous assessment as an essential part of the evaluation process. Nevertheless, the way in which the continuous assessment is applied or understood depends on the subject, and in a way, on the lecturers. Some professors take into account the participation and the attendance as part of the assessment, whereas some others consider besides the final exam the delivery of some activities during the term. Likewise there are some Universities that have established regulations related to how the assessment should be integrated along the courses as the University of Barcelona did, [1]. In the framework of the Bologna process, for the case we analyze here, the main change in the assessment has consisted of introducing several mid-term tests in which some positive marks are accumulated, the purpose of these small exams in a course of Mathematics is to make easier to the students to pass the subject by taking exams of small group of contents, therefore the students have now more than one mark as part of the evaluation process. For the course considered here, Mathematics for Business, the continuous part of the evaluation represents a 40% of the final mark and consists in

two tests the students have to complete during the term. The students cannot retrieve or retake the tests to improve the mark obtained in the continuous assessment, consequently the score obtained in these two tests will be added to the score achieved in the final exam. A particular feature to be remarkable of the course we study here is that belongs to the first term of the first academic year in the Faculty of Economics, Business and Tourism, one of the most populated school at the University, it is precisely for that reason that there are many students in matriculated in the subject, eight groups of more than 80 students. In addition, according to the evaluation rules of the University, the final exam of a subject has to be the same for all the students, however due to constraints of time and space the mid-term exams have to be taken during the regular period of lessons hence a large quantity of different tests have to be prepared by the lecturers in order to prevent, on the one hand, cheating, and on the other hand the flow of information among the students because they carry out the examination in different hours along the same day. Moreover, to be fair and guarantee the students are evaluated under the same conditions the different test have to be prepared with the same level of difficulty, in short it is necessary a previous hard work consisting on preparing different exams corresponding to different versions and later on controlling the process of the exam.

In this work we provide an efficient and effective way to elaborate random multiple choice examination tests (papers are also possible) by using *Mathematica* (see [2]) and L^AT_EX. The reader interesting in this compiler are invited to read the work of [3]. Using these two tools we are able to generate in an easy way different PDF documents created by L^AT_EX. At the same time solutions are provided to easily correct the exams, these solutions are available not only for lecturers but also could be given to the students when the examination process has concluded, thus they could proceed to make a correction by themselves.

The work is structured as follows. The methodology and the results are given in Section II and Conclusions in Section III. An Appendix Section is provided at the end of the work to show the main documents needed to get the target and the *Mathematica* code.

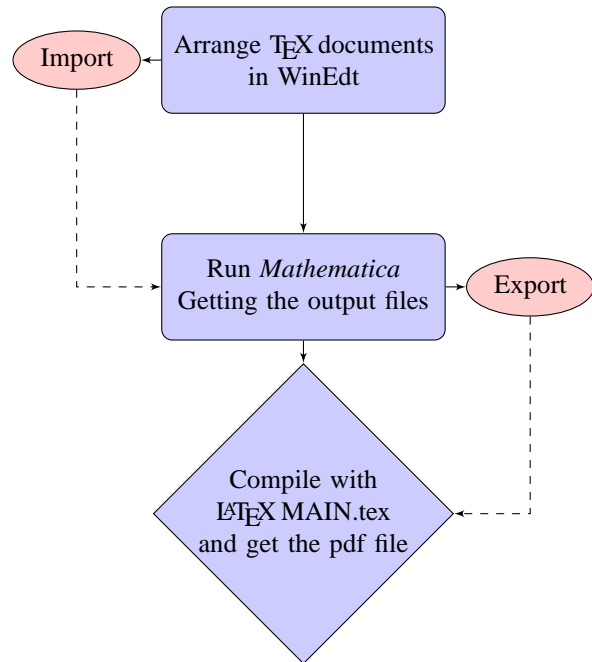
II. METHODOLOGY AND RESULTS

In order to get the target we need firstly to prepare in \TeX commands two kinds of files and a main file which will be running at the end to generate the exams. We recommend to use the WinEdt editor, which is a powerful and versatile all-purpose text editor for Windows with a strong predisposition towards the creation of \LaTeX documents. This editor is available (previous fee) in the web page <http://www.winedt.com/>. Any other text editor is possible to be used but the main advantage of WinEdt is that allow to dealing different lines as a unique line by using wrapping (see the manual of WinEdt available in the web). The first type of \TeX files includes the different questions which are going to be part of the exam. These files contain the banks of question to allow us to create a repository of test questions. In our example we have worked with five topics to be questioned to the students. They contain basic questions about Calculus and are (i) Domain of a function, (ii) Composition operator, (iii) Inverse of a function, (iv) Monotony of functions and (v) Integrals. The order of the questions in the exams are arranged in the order in which the material is explained in class, although the influence of the item sequence with the performance of the students on multiple choice exams does not significantly affect students exam scores as it has been analyzed by [4] among others and [5] even found that the order of questions has not statistically significant effect on exam scores, even after including variables that reflect differential student-specific human capital characteristics. We note that in this case we refer to functions of a real variable. Here, they are denoted as $t_1.tex$, $t_2.tex$, ..., $t_5.tex$, respectively. The other type of files are mentioned as $EXAMEN_1.tex$, $EXAMEN_2.tex$, ... The body of these types of files is the same but different for the case of we need to generate one exam, two different exams, etc. The main file to be compiled in \LaTeX includes only a preamble (as usual in all \LaTeX documents) and a main body with the usual entries and an input of the file between them containing the(s) exam(s) by using $\backslashinput\{exam\}$, where the exam.tex file was built automatically by *Mathematica*. An example of these types of files can be viewed in the Appendix Section of this work. The *Mathematica* code to get the different tex files is also given in the Appendix section.

All the *Mathematica* commands used are simple and standard and detailed information is provided after them into (**). As you can see Import is needed to get the appropriate files, Export to save the files generate by *Mathematica* and the main command to be used is Table together with Do, which uses the standard Wolfram Language iteration specification. Additionally to the files mentioned *Mathematica* generates the simple files date.tex, subject.tex, typeexam.tex, degree.tex and tableqa.tex in order to print into the file EXAMEN.tex the corresponding date of the exam, the subject, the type of the exam, the degree and the table of response where the students have to mark the response they consider that it is correct. *Mathematica* also provides the table of correct answers

(responses are labelled with the corresponding labels) which is saved in the file finaltable.tex. This final table including the right answers for all the generated models might be provided also to the students, needless to say that once the examination process has finished, so they might have an idea of the score of the exam in advance. An example with two types of exams with five questions is provided and the pdf file generated by \LaTeX is shown in the Appendix Section.

A simple organigram of the process is given below.



III. CONCLUSIONS

In this work we provide an efficient and effective way to elaborate random examination tests (papers are also possible) by using *Mathematica* package and \LaTeX . Using these two tools we are able to generate, in an easy way, different PDF documents created by \LaTeX . At the same time solutions are provided to easily correct them.

The questions on the generated exams include the topics in the same order they are presented in the contents of the course because in this way it has been decided at the moment of designing the output of the program but this order could be scrambled. Depending on the bank of questions for each topic the probability of repeating questions is lower. With regard to the answers, as the right questions are labeled the order in which they are shown could be scrambled with the automatic change in the complete solution table provided to the students in order they could have an idea of their marks.

REFERENCES

- [1] E. G. G. D. M. Estivil and M. C. Ramió, "The european higher education area at work: Lights and shadows defining continuous assessment," *Revista d'Innovació Docent Universitària*, vol. 2, 2010.
- [2] S. Wolfram, *The Mathematica Book*. Wolfram Media, Inc., 2003.

- [3] C. Brooks, *BTX*. Revista digital Matemática. Educación e Internet, 2013.
- [4] J.L. Carlson and L. Ostrosky, "Item sequence and student performance on multiple-choice exams: Further evidence," *The Journal of Economic Education*, vol. 23, no. 3, pp. 232-235, 1992.
- [5] S. Caudill and D. Gropper, "Test structure, human capital, and student performance on economics exams," *The Journal of Economic Education*, vol. 22, no. 4, pp. 303-306, 1991.

Acknowledgements: EGD partially funded by grant ECO2013-47092 (Ministerio de Economía y Competitividad, Spain).

APPENDIX

Mathematica code

```

1 numberquestions = 5; (* write the number of questions *)
2 numex = 2; (* write the number of exams to generate *)
3 date = TextForm["January_15th_2015"];
4 (* write between commas the date of the exam *)
5 subject = TextForm["Maths"];
6 (* write between commas the subject *)
7 typeexam = TextForm["First_exercise"];
8 (* write between commas the type of exam *)
9 degree = TextForm["Degree_in_Business_Administration"];
10 (* write between commas the degree *)
11 tableqa = Grid[Table[{j, a, b, c}, {j, 1, numberquestions}],
12   Dividers -> All] // Text;
13 (* building the table of responses *)
14 Exam = Import["C:\\Users\\Desktop\\EXAMEN_" <> ToString[
15   numex] <> ".tex", "List"];
16 Export["C:\\Users\\Desktop\\date.tex", date, "Table"];
17 Export["C:\\Users\\Desktop\\EXAM.tex", Exam, "Table"];
18 Export["C:\\Users\\Desktop\\subject.tex", subject, "Table"];
19 Export["C:\\Users\\Desktop\\typeexam.tex", typeexam, "Table"];
20 Export["C:\\Users\\Desktop\\degree.tex", degree, "Table"];
21 Export["C:\\Users\\Desktop\\tableqa.tex", tableqa, "TeXFragment"];
22 allqr = Table[Import["C:\\Users\\Desktop\\t_" <> ToString[i] <>
23   ".tex",
24   "List"], {i, 1, numberquestions}];
25 (* importing files with all topics and questions and responses *)
26 m = Table[Length[allqr[[i]]], {i, 1, numberquestions}];
27 (* gives the length of topic i *)
28 allq = Table[allqr[[i]][[2* j - 1]], {i, 1, numberquestions}, {j, 1, m[[i]
29   ]/2}];
30 (* all questions of topic i *)
31 allr = Table[allqr[[i]][[2* j]], {i, 1, numberquestions}, {j, 1, m[[i]
32   ]/2}];
33 (* all responses of topic i *)
34 Do[
35   type = j; (* gives the version of the exam. Types 1,2,..., numex *)
36   ttj = Flatten[
37     Table[RandomChoice[allq[[i]], 1], {i, 1, numberquestions}]];
38   (* choose random question of topic i and convert to a table without
39     internal brackets *)
40   ptij = Flatten[Table[Position[allqr[[i]], ttj[[i]], {i, 1,
41     numberquestions}]];
42   (* position of the question chosen in the list t11all and convert to
43     a table without internal brackets *)
44   outexamen = TableForm[Table[ttj[[i]], {i, 1, numberquestions}]];
45   (* questions chosen *)
46   outanswers = TableForm[Table[allqr[[i]][[ ptij[[i] + 1]], {i, 1,
47     numberquestions}]];
48   (* build the table of responses *)
49   Export["C:\\Users\\Desktop\\type_" <> ToString[j] <> ".tex",
50     type, "Table"];
51   Export["C:\\Users\\Desktop\\outexamen_" <> ToString[j] <> ".
52     tex", outexamen, "Table"];
53   Export["C:\\Users\\Desktop\\outanswer_" <> ToString[j] <> ".
54     tex", outanswers, "Table"];
55   {j, 1, numex}];
56 importresponses = Table[Import["C:\\Users\\Desktop\\outanswer_"
57   <> ToString[i] <> ".tex",

```

```

"List"], {i, 1, numex}];
finaltable = TableForm[Table[Insert[Insert[Insert[Insert[Riffle[
importresponses[[s]], "&"],
"\\\\", -1], "Type", 1], ":", 2], s, 2], {s, 1, numex}]];
Export["C:\\Users\\Desktop\\finaltable.tex", finaltable, "Table"];

```

Main document MAIN.tex (to be compiled)

```

\documentclass[10pt]{article}

\pagestyle{empty}
\def \R {{\rm I\kern -2.2pt R\hskip 1pt}}
\oddsidemargin=-0.25cm\evensidemargin=-0.25cm
\textwidth=180mm\textheight=270mm
\topmargin=-105pt\headheight=12truept
\headsep=25pt\footskip=17pt
\hoffset=1mm\voffset=4mm

```

```

\begin{document}
\input{exam}
\end{document}

```

Example of file EXAM_2.tex (arranged for two types of exams)

```

\newpage
\begin{titlepage} \noindent {\large \bf \input{subject}
\hfill {\input{date}}\ \input{typeexam}}\ \sc \input{title}
\hfill {Type \input{type_1}}\ \ \ \
{ \sc First name.....}
\hfill {\sc Surname.....}}\ \
\begin{enumerate} { \input{outexamen_1}} \end{enumerate}
\vspace{0.5cm}
\noindent {\sf Put in the following table a {\Large $\times$}
in the correct answer.}\ \ \
\Large \input{tableqa}
\end{titlepage}
\newpage
\begin{titlepage} \noindent {\large \bf \input{subject}
\hfill {\input{date}}\ \input{typeexam}}\ \sc \input{title}
\hfill {Type \input{type_2}}\ \ \ \
{ \sc First name.....}
\hfill {\sc Surname.....}}\ \
\begin{enumerate} { \input{outexamen_2}} \end{enumerate}
\vspace{0.5cm}
\noindent {\sf Put in the following table a {\Large $\times$}
in the correct answer.}\ \ \
\Large \input{tableqa}
\end{titlepage}
\begin{titlepage}
\vspace*{2cm}\noindent \Large
\input{degree} \Subject: \input{subject}\ \input{typeexam}
\input{date}
\vspace{1cm}
\begin{center}
{\sc Solutions}
\end{center}
\vspace{0.5cm}
\begin{table}[h]
\begin{center}
\begin{tabular}{cccccc}
\input{finaltable}\ \
\end{tabular}
\end{center}
\end{table}
\end{titlepage}

```

Example of file t_5.tex (a bank of questions)

In Figure 1 we show the code for the file t5.tex, a bank of questions corresponding to the topic Integration.

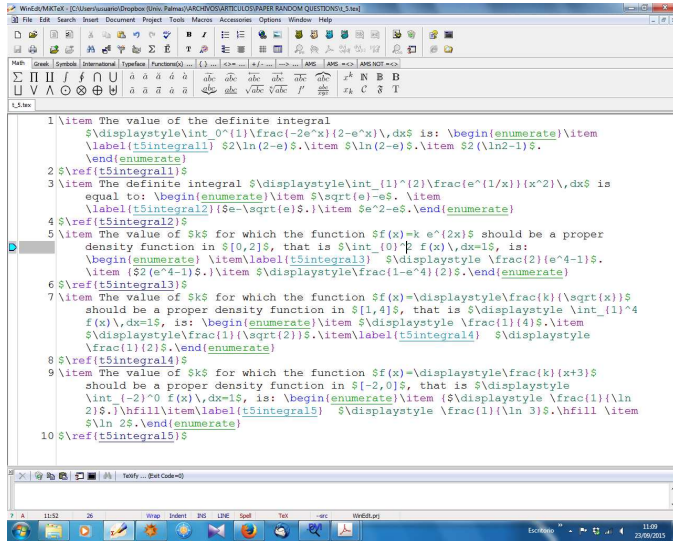


Fig. 1. File t_5.tex

Final exam

Figure 2 shows the final exam obtained after compiling the main document in L^AT_EX and get the pdf file.

- The domain of the function $f(x) = \frac{e^{2x-1}}{\sqrt{x}}$ is:
 - Dom(f) = (0, 1].
 - Dom(f) = (0, 1) ∪ (1, +∞).
 - Dom(f) = (0, +∞).
- Given the functions $f(x) = \sqrt{x-2}$, $g(x) = x^2 + 1$, then the domain of the function $(f \circ g)(x)$ is:
 - (-∞, -1] ∪ [1, +∞).
 - (-∞, -1) ∪ (1, +∞).
 - ∅.
- The inverse of the function $y = \frac{x+2}{x-2}$ is given by:
 - $x = \frac{2y+2}{1-y}$
 - $x = \frac{y-1}{2y+2}$
 - $x = \frac{2y+2}{y-1}$
- The function $f(x) = \frac{1+2x}{3x-1}$:
 - Is decreasing in its domain.
 - Has a local maximum in $x = 5$.
 - Is increasing in its domain.
- The value of the definite integral $\int_0^1 \frac{-2e^x}{2-e^x} dx$ is:
 - $2\ln(2-e)$.
 - $\ln(2-e)$.
 - $2\ln(2-1)$.

Put in the following table a × in the correct answer.

1	a	b	c
2	a	b	c
3	a	b	c
4	a	b	c
5	a	b	c

- The domain of the function $f(x) = \frac{\sqrt{x}}{x-1}$ is:
 - Dom(f) = [0, 1) ∪ (1, +∞).
 - Dom(f) = (0, 1) ∪ (1, +∞).
 - Dom(f) = (0, 1) ∪ [1, +∞).
- Given the functions $f(x) = 1 - x^2$ y $g(x) = x + 1$, then $(f \circ g)(x)$ is given by:
 - $x(x+2)$.
 - $2 - x^2$.
 - $-x(x+2)$.
- The inverse of the function $y = \frac{x+2}{x-2}$ is given by:
 - $x = \frac{2y+2}{1-y}$
 - $x = \frac{y-1}{2y+2}$
 - $x = \frac{2y+2}{y-1}$
- The function $f(x) = (x^2 - 3)e^x$ is:
 - Decreasing in \mathbb{R} (-3, 1).
 - Decreasing in $(-\infty, -3) \cup (1, +\infty)$.
 - Increasing in $(-3, +\infty)$.
- The value of k for which the function $f(x) = \frac{k}{\sqrt{x}}$ should be a proper density function in [1, 4], that is $\int_1^4 f(x) dx = 1$, is:
 - $\frac{1}{4}$.
 - $\frac{1}{\sqrt{2}}$.
 - $\frac{1}{2}$.

Put in the following table a × in the correct answer.

1	a	b	c
2	a	b	c
3	a	b	c
4	a	b	c
5	a	b	c

SOLUTIONS

Type 1 : 1c 2a 3c 4a 5a
Type 2 : 1a 2c 3c 4a 5c

Fig. 2. Final exam in pdf