



LACLO-  
LALA  
JINIS

3 CONFERENCIAS SIMULTANEAS

Del 19 al 21 de Octubre,

# Automated assessment of parametric programming in a large-scale course

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- Motivation
- Materials and methods
  - **Parametric Questions with code (PQ) to Discussion**
    - Proposal to integrate MCTest and VPL:
      - ⇒ applied in [CSEDU-2019] **without PQ in VPL**
      - ⇒ applied in [SBIE-2020] **with PQ, using model.txt**
      - ⇒ applied in [LACLO-2021] **with PQ and automatic test cases**
- Preliminary results
- Conclusion and Future Works

# Motivation

- How to generate exams for many students?
  - Using a web platform with database of questions
  - Dedicated to Education Systems
- How to minimize fraud?
  - An exam in which the questions are **unique to each student**
- How to correct this exam automatically?
  - Using Moodle with VPL plugin.

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# Proposal to integrate MCTest and VPL [CSEDU-2019]

- **Proposal to integrate MCTest and VPL**

- MCTest ⇒ **first online version:**

- Zampirolli, F., Teubl, F., and Batista, V. (2019). Online generator and corrector of parametric questions in hard copy useful for the elaboration of thousands of individualized exams. In CSEDU (1), pages 352–359.

- **Virtual Programming Lab (VPL):**

- Rodríguez-del Pino, J. C., Rubio Royo, E., and Hernández Figueroa, Z. (2012). A virtual programming lab for moodle with automatic assessment and anti-plagiarism features. Conference: International Conference on e-Learning, e-Business, Enterprise Information Systems, & e-Government
- <https://vpl.dis.ulpgc.es>

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# Proposal to integrate MCTest and VPL [SBIE-2020]

Zampirolli, F.A., Pisani, P.H., Josko, J.M.B., Kobayashi, G., Fraga, F., Goya, D., Savegnago, H.R. "Parameterized and automated assessment on an introductory programming course". SBIE, Natal, 2020.

- In MCTest, we program questions to draw **random models** presented in the description
- After a Moodle VPL activity is created and in runtime files, the teacher would have:
  - to add text cases: \_\_\_\_\_ →
  - and other files available at:  
[github.com/fzampirolli/mctest/VPL\\_modification/V1-select\\_using\\_second\\_file](https://github.com/fzampirolli/mctest/VPL_modification/V1-select_using_second_file)
- In Moodle, student sends **question.java** and
  - **model.txt** (containing only one line, e.g. "**model: F**")

```
vpl_evaluate_A.cases  
vpl_evaluate_B.cases  
vpl_evaluate_C.cases  
vpl_evaluate_D.cases  
vpl_evaluate_E.cases  
vpl_evaluate_F.cases
```



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# Method: Update **Exam** - our main contribution [LACLO-2021]

Before creating the exams in the button above, first create the variations. It is necessary to create new variations of the exam each time you change the questions and the number of variations in the attributes below. The options marked below will be sent to your email.

**Create-Variations**  Json  Template  Aiken  XML  LaTeX+PDF

Name: FCS-List01

Choose Classrooms:  CBS-C01 \*  CBS-C02 \*

**Questions List**

copy csv excel pdf print column visibility ▾

Search:

> <input type="checkbox"/> ↑	Topic	Description	Type	Dif.	Group	Par.	See
<input checked="" type="checkbox"/>	template	divide-price	QT	1	<input type="checkbox"/>	yes	1652
<input checked="" type="checkbox"/>	template	grade of student	QT	1	<input type="checkbox"/>	yes	1059
<input type="checkbox"/>	template	conceito 1D 2D 3D - en	QM	1	<input type="checkbox"/>	yes	1237

**linker.json** with test cases

- **CBS-C01.pdf** and **CBS-C02.pdf** with all exams to print or email to each student
- **students\_variations.csv** with variation of each student

# Method: Update **Question** - our main contribution [LACLO-2021]

## Question Update

<a href="#">Create-PDF</a> See this question in PDF format	<a href="#">Compile-Colab</a> Copy-Paste the description of question for test in Colab Google	<a href="#">Save-Json</a> It will save all your questions to a file in json format
Choose Topic	[Ex]<template>	
Short Description	divide-price	
Group	Only one question per group will be sorted for each exam	
Description	Write a program that helps a store make a sale. Your program should: Ask the product price; Consider that the store divides this price in just <code>[[code:parcelas]]</code> installments (without addition); and show how much it will cost each month (rounding to two decimal places only). See the example below:	

#1652 1. Write a program that helps a store make a sale. Your program should: Ask the product price; Consider that the store divides this price in just 20 installments (without addition); and show how much it will cost each month (rounding to two decimal places only). See the example below:

Input Example:

715.78

Output Example:

35.79

# Method: Update **Question** - our main contribution [LACLO-2021]

#1652 1. Write a program that helps a store make a sale. Your program should: Ask the product price; Consider that the store divides this price in just 20 installments (without addition); and show how much it will cost each month (rounding to two decimal places only). See the example below:

Input Example:  
715.78

Output Example:  
35.79

Write a program that helps a store make a sale. Your program should: Ask the product price; Consider that the store divides this price in just `[[code:parcelas]]` installments (without addition); and show how much it will cost each month (rounding to two decimal places only). See the example below:

noindent Input Example:  
`\begin{verbatim}`  
`[[code:caso0_inp]]`  
`\end{verbatim}`

noindent Output Example:  
`\begin{verbatim}`  
`[[code:caso0_out]]`  
`\end{verbatim}`

`\begin{comment}` % needed to generate test cases in moodle  
`[[code:moodle_cases]]`  
`\end{comment}`

`[[def:`  
# see the figure on the right  
`]]`

linker.json with test cases:

```
{
  "input": ["715.78", "556.46", ...],
  "output": ["35.79", "27.82", ...]
}
```

```
1 import json
2 import numpy as np
3
4 # PARAMETERS USED IN QUESTION DESCRIPTION
5 #>>> BEGIN
6 # use random to have a different question for each student
7 parcelas = np.random.randint(11,24)
8 #<<<< END
9
10 inp_list, out_list, casos_teste = [], [], 4 #n.test cases-CHANGE
11 for i in range(casos_teste):
12
13     #>>> BEGIN THE SOLUTION OF THE QUESTION
14     # in this example, the value must be read as an entry to be
15     # assessment in Moodle. Use random to have different test cases
16     valor = np.random.randint(50000,81000)/100
17     inp = str(valor)+'\n'
18     out = '%.2F' % (valor/parcelas)
19     #<<<< END OF QUESTION SOLUTION
20
21     # list of test cases
22     inp_list.append(inp)
23     out_list.append(out)
24
25 cases = {}
26 cases['input'] = np.array(inp_list).tolist()
27 cases['output'] = np.array(out_list).tolist()
28 moodle_cases = json.dumps(cases)
29
30 # to show an example in the question description
31 caso0_inp = cases['input'][0]
32 caso0_out = cases['output'][0]
```

# Proposal to integrate MCTest and VPL [LACLO-2021]

- In MCTest, we program parametric questions like the one presented in this paper
- After a Moodle VPL activity is created in runtime files, the teacher would have to add:
  - **linker.json** with test cases
  - **students\_variations.csv** with variation of each student
  - and other files available at:  
[github.com/fzampirolli/mctest/VPL\\_modification/V10-new\\_selector](https://github.com/fzampirolli/mctest/VPL_modification/V10-new_selector)
- In Moodle, student sends only **question.\*** (java, js, c, cpp, r, py)

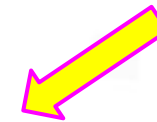
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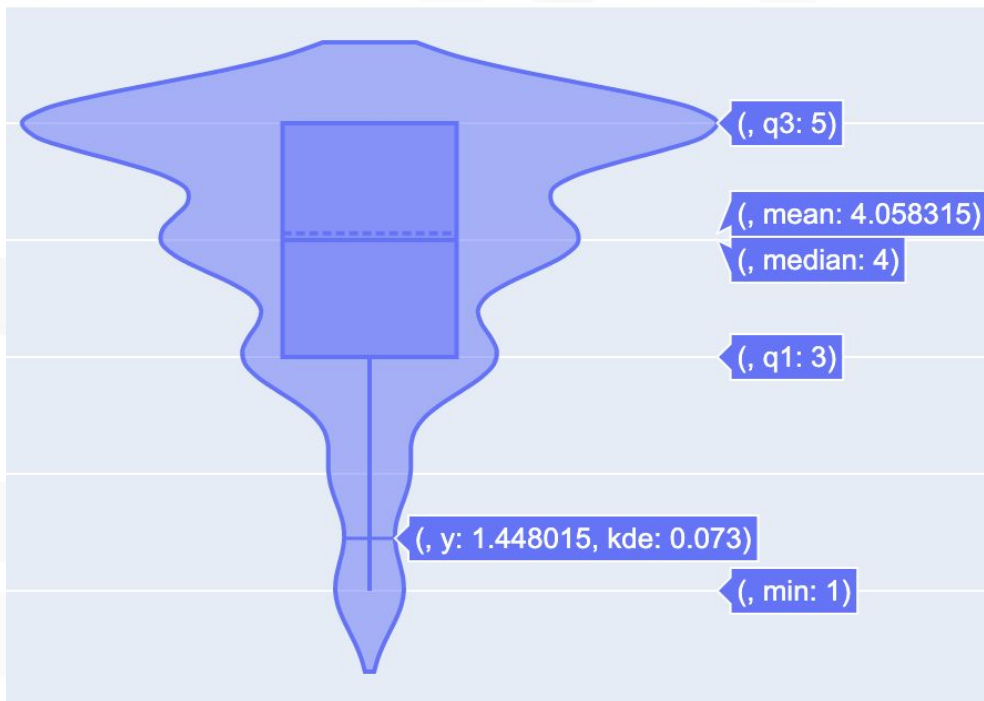


# Preliminary results

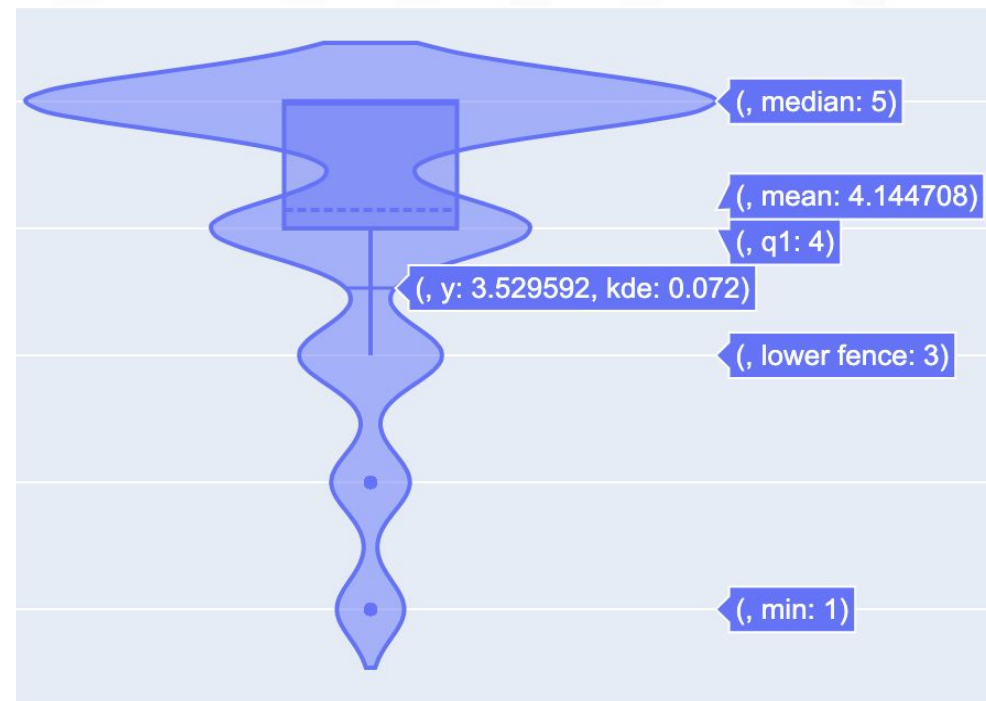
- Computational Bases of Science Course in 2020
- 1407 students in 43 laboratory (12 weeks, 2h each)
- **Unified weekly lists of programming exercises in Python**
- **Teaching material in Colab**
- Our method was used by 28 classes  $\Rightarrow$  **900 students**
- A questionnaire sent to the students returned 443 responses, with preferences:
  - Colab (67%), slides (18%) and Moodle activities (15%)
  - **Around 82% of the respondents approved our method**



# Preliminary results: **MCTest+Moodle+VPL**



Unified weekly lists of  
programming exercises



Automatic corrections  
of exercises on Moodle



# Conclusion

- How to generate exams for many students?
  - Using a web platform with **database of questions**
  - Dedicated to Education Systems  
⇒ e.g.: **MCTest**
- How to minimize fraud?
  - An exam in which the **questions are unique** to each student  
⇒ **Parametric Questions in MCTest**
- How to correct exams automatically?
  - Using Moodle with VPL plugin  
⇒ **MCTest+Moodle+VPL**

# Future work

- Elaboration of **more parameterized questions** to be drawn for the evaluations, contributing to plagiarism prevention
- We **offer free training** so that this service can be used by more people:
  - install MCTest in different institutions
  - for teachers to use

# Thanks!

## Questions?

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