Online Generator and Corrector of Parametric Questions in Hard Copy Useful for the Elaboration of Thousands of Individualized Exams

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- Conclusion and Future Works

Motivation

- How to generate exams for many students?
  - For many purposes online exams aren't reliable.
  - Traditional paper exams are then required.

- How to minimize fraud?
  - An exam in which the questions are unique to each student.

- How to correct this exam automatically?
  - With computer vision applied to the scanned image of the answer sheets.

Method: website

- webMCTest
- All institutes
- All courses
- All disciplines
- All topics
- All questions
- All exams

- User: fzampirolli
  - Questions
  - Classrooms
  - Exams

  - Admin
  - Logout
- Sign up

webMCTest

(Portuguese version with different DB)
Welcome to *webMCTest*, a website developed as an application on the MCTest [ref16a; GitHub]

Dynamic content

The webMCTest has the following record counts:

- **Institutes:** 2 [Institute has Courses]
- **Courses:** 2 [Course has Disciplines]
- **Disciplines:** 2 [Discipline has Topics and Classrooms]
- **Classrooms:** 1 [Classroom has Exams, Profs and Student]
- **Exams:** 1 [Exam has Classrooms and Questions] - motivations [ref18a]
- **Topics:** 15 [Topic has Questions]

- **Questions:** 14 - motivations for the use of bloom taxonomy [ref17cap2; ref18b]
  - **Multiple Choice:** 12
  - **Text:** 2
  - **Parametric:** 12 [ref19a; ref19b]
- **Users:** 3

In this paper

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Method: website

- webMCTest
- Institutos
- Cursos
- Disciplinas
- Tópicos
- Questões
- Exames

- Usuário: fzampirolli
  - Questões
  - Turmas
  - Exames

  - Admin
  - Sair
- Inscrever

webMCTest

(English version with different DB)

Ver Backup de 2018 em outro servidor.

Bem vindo ao *webMCTest*, um portal (em constante manutenção) para a geração e correção de exames, uma ampliação do MCTest [ref16a; GitHub]
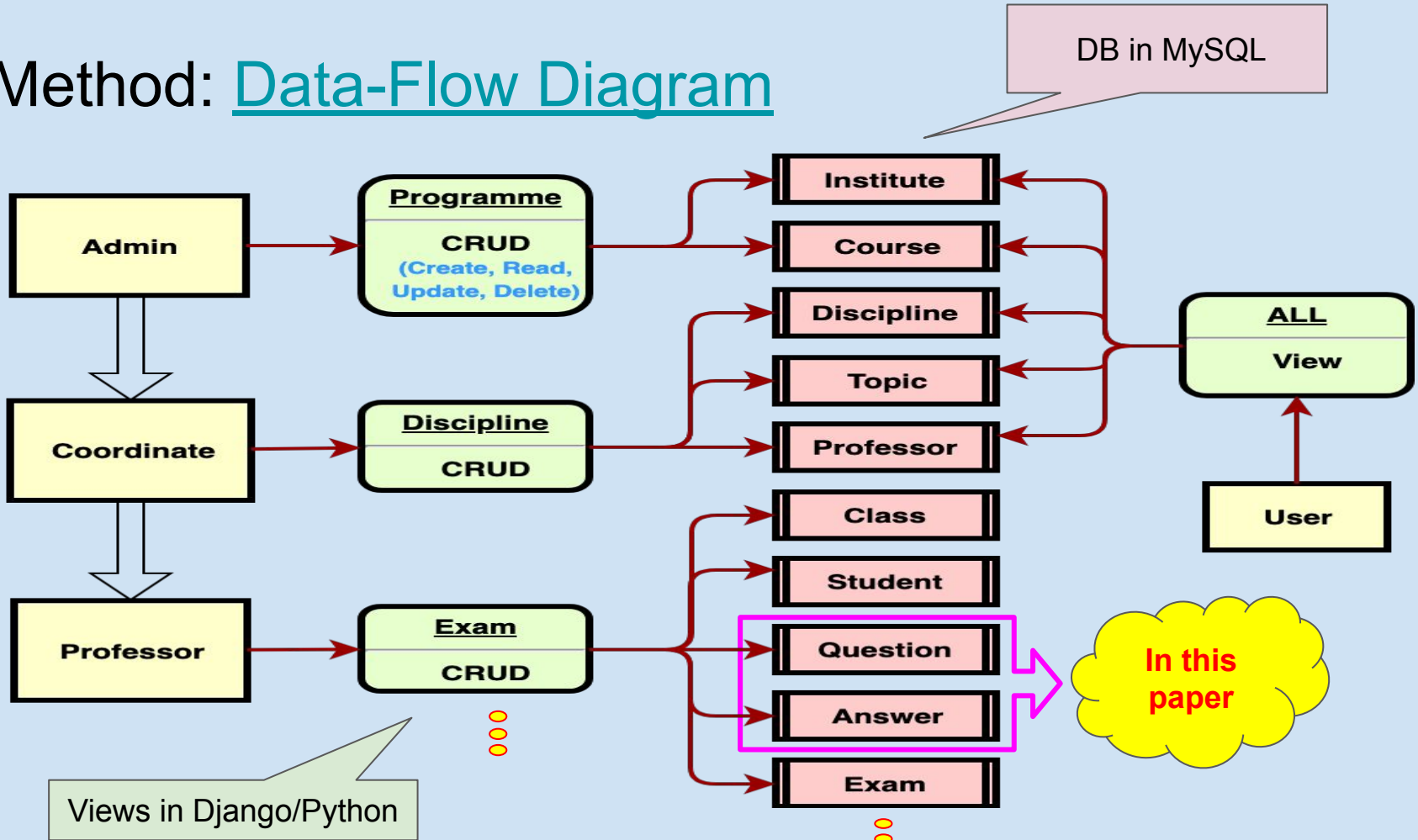
Conteúdo dinâmico

O webMCTest tem os seguintes contadores:

Dynamic Contents, since February, 2019

- **Institutos:** 3 [Instituto tem Cursos]
- **Cursos:** 7 [Curso tem Disciplinas]
- **Disciplinas:** 14 [Disciplina tem Tópicos, Turmas e Profs]
- **Turmas:** 140 [Turmas tem Exames, Profs e Estudantes]
- **Exames:** 42 [Exame tem Turmas e Questões] - motivações [ref18a]
- **Tópicos:** 34 [Tópico tem Questões]

- **Questões:** 306 - motivações para o uso da taxonomia de bloom [ref17cap2; ref18b]
  - **Múltipla Escolha:** 182
  - **Dissertativa:** 124
  - **Paramétrica:** 87 [ref19a; ref19b]
- **Usuários:** 57

In this paper
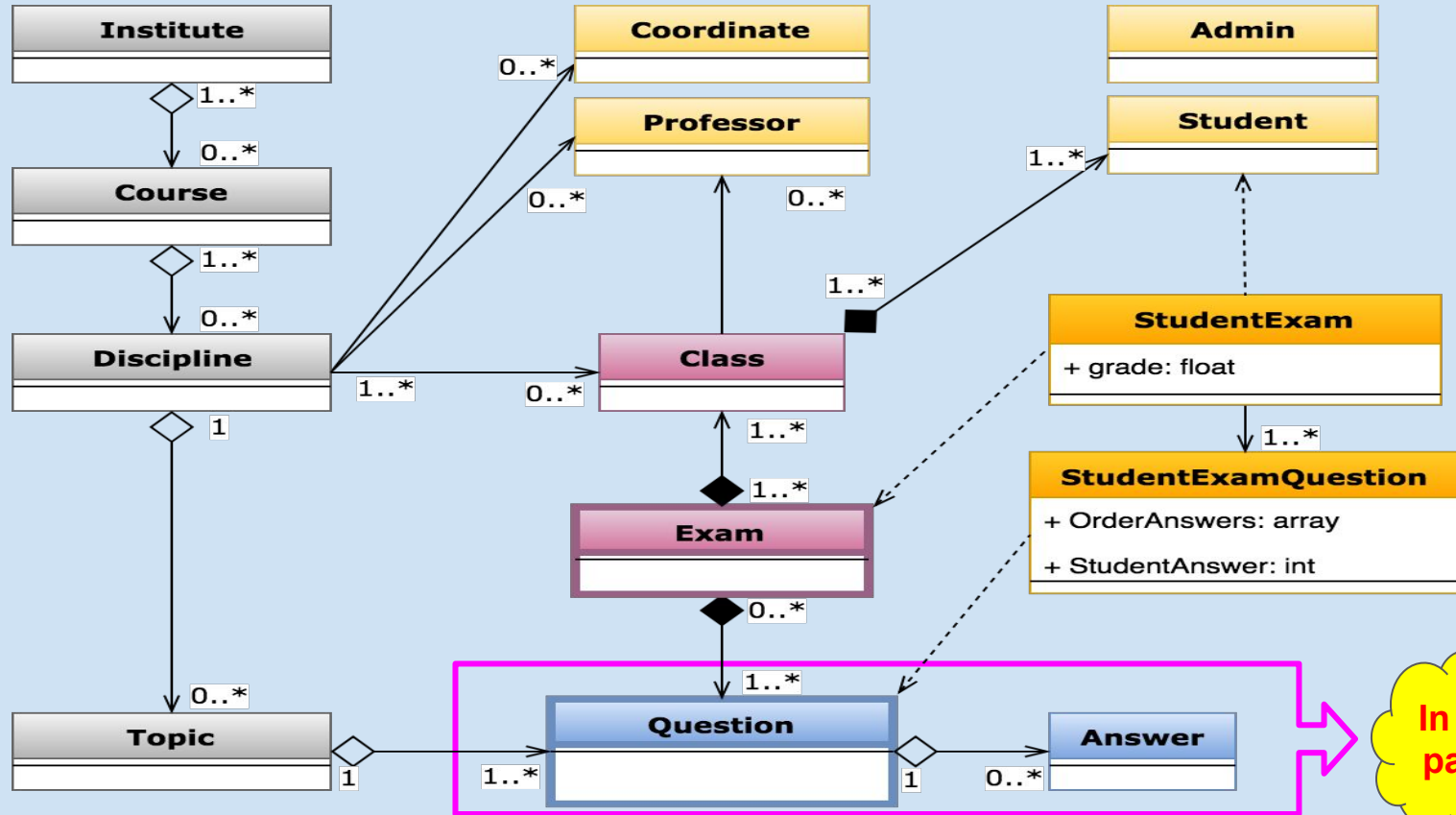
Method: Data-Flow Diagram

DB in MySQL

Admin

Programme
CRUD
(Create, Read, Update, Delete)

Coordinate

Discipline
CRUD

Professor

Exam
CRUD

Views in Django/Python

Institute

Course

Discipline

Topic

Professor

Class

Student

Question

Answer

Exam

ALL
View

User

In this paper

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Method: Class Diagram (**M**odel in **M**VC architecture)

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Method: Create Question

- webMCTest
- All institutes
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- All disciplines
- All topics
- All questions
- All exams

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Topic: ---------

Short Description:

Question Group:

Only one question per group will be sorted for each exam (student)

Description:

Type: Multiple-Choice Question

Difficulty: Very easy level question

Bloom Taxonomy: remember: recognizing, recalling

Parametric question: No

Question with some randomly chosen values

Submit

Click in Update Question in My Questions to create the answers.

Method:

Question Update

Save-Json

It will save all your questions to a file in json forma

Topic: [TMP]<equation-parametric> ⬍

Short Description: template-equation-parar

Group:

Only one question per group will be sorted for each exam

Description:

Write a $3\times$ [[code:a1]] $ matrix of integers, with elements $ (i, j) = i + j $.\\
Indexes start at zero. What is the average of the last column?

[[def:
# for test: https://repl.it/languages/python
a1 = random.randrange(2,7, 1)
# a random number between 2 and 6
a0 = 3

A=np.zeros((a0, a1), dtype=np.int)
for i in range(a0):
  for j in range(a1):
    A[i][j]=i+j

global correctAnswer
correctAnswer = np.average(A[2])
]]

Description (you can include latex format)

Method:Update Question

Type:	Multiple-Choice Question ⬍
Difficulty:	Very easy level question ⬍
Bloom Taxonomy:	remember: recognizing, recalling ⬍
Parametric question:	Yes ⬍
	Question with some randomly chosen values
Who Created:	omitted@ufabc.edu.br ⬍
Last Update:	2018-11-09

Method:Update Question

Answer Text: [[code:correctAnswer]] % correct answer – always the first

Answer Feedback:

Delete: ☐

Answer Text: [[code:correctAnswer-1]]

Answer Feedback:

Delete: ☐

Answer Text:

Answer Feedback:

Delete: ☐

Submit

Delete

Method: Question Update

See-PDF

See this question in PDF format

Description of Question:

```
Write a $3\times [[code:a1]] $ matrix of integers, with elements $ (i, j) = i + j $.\\
Indexes start at zero. What is the average of the last line?

[[def:
# for test: https://repl.it/languages/python
a1 = random.randrange(2,7, 1)
# a random number between 2 and 6
a0 = 3

# create a matrix
A=np.zeros((a0, a1), dtype=np.int)

for i in range(a0):   # for each line
  for j in range(a1): # for each column
    A[i][j]=i+j

global correctAnswer
correctAnswer = np.average(A[a0-1])
]]
```

webMCTest

Topic: equation-parametric
Group:
Short Description: template-equation-parametric0
Type: QM
Difficulty: 1
Bloom taxonomy: remember
Last update: 2018-11-09
Who created: omitted@ufabc.edu.br

#002 1. Write a 3×2 matrix of integers, with elements $(i, j) = i + j$. Indexes start at zero. What is the average of the last line?

A.*₁1.5   B.*₃6.5   C.*₂4.5   D.#₀2.5   E.*₄7.5

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- Conclusion and Future Works

Example with Equation and Figure

What is the result of the equation:

$$[[code:a0]]$$

Illustrated in the figure below:

```
\begin{figure}[h]
  \centering
  \includegraphics[scale=0.5]{fzprof_fig01_001}
\end{figure}

[[def:
a6 = random.randrange(3, 8, 1)

fig = plt.gcf()
var('x')
plot(sin(x)**2+x+a6,(x,0, 2*pi))

fig.savefig('./tmp/fzprof_fig01_001.png')

x = symbols('x')
f = sin(x)**2+x+a6
a0 = latex(Integral(f, x))

a1 = latex(integrate(f, x))
a2 = latex(integrate(f*x, x))
a3 = latex(integrate(f/x, x))
a4 = latex(integrate(x**5 + x + 1, x))
a5 = latex(integrate(x**6 + x + 1, x))
]]
```

SymPy library

#007 1. What is the result of the equation:

$$\int \left(x + \sin^2(x) + 5 \right)\, dx$$

Illustrated in the figure below:
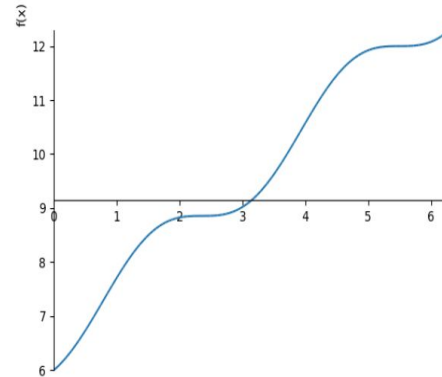
A. *4 $\frac{x^7}{7} + \frac{x^2}{2} + x$ B. #0 $\frac{x^2}{2} + \frac{11x}{2} - \frac{\sin(x)\cos(x)}{2}$ C. *1 $\frac{x^3}{3} + \frac{x^2 \sin^2(x)}{4} + \frac{x^2 \cos^2(x)}{4} + \frac{5x^2}{2} - \frac{x\sin(x)\cos(x)}{2} - \frac{\cos^2(x)}{4}$

D. *2 $x + \frac{11\log(x)}{2} - \frac{\mathrm{Ci}(2x)}{2}$ E. *3 $\frac{x^6}{6} + \frac{x^2}{2} + x$

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Example with Graph

```
What is the Dijkstra path in this graph, between $a$ and $d$ nodes, \\
with weights [[code:e_weighted]]?

\begin{figure}[h]
  \includegraphics[scale=0.5]{fzprof_fig00.png}
\end{figure}

[[def:
import matplotlib.pyplot as plt
import networkx as nx

a0=random.randrange(2,6,1)/10.0
a1=random.randrange(2,5,1)/10.0
a2=random.randrange(5,8,1)/10.0
a3=random.randrange(10,14,1)/10.0

plt.clf()

G=nx.Graph()
e=[('a','b',a0),('b','c',a1),('a','c',a2),('c','d',a3)]
G.add_weighted_edges_from(e)

e_weighted = str(e)
out = str(nx.dijkstra_path(G,'a','d'))
out1 = str(nx.dijkstra_path(G,'a','c'))
out2 = str(nx.dijkstra_path(G,'b','d'))

plt.show()

pos=nx.spring_layout(G) # positions for all nodes
nx.draw(G,pos=pos)
nx.draw_networkx_labels(G,pos=pos)
nx.draw_networkx_edge_labels(G,pos=pos)

plt.savefig('./tmp/fzprof_fig00.png') # save as png
]]
```

networkx and matplotlib library

#010 1. What is the Dijkstra path in this graph, between a and d nodes, with weights $[('a', 'b', 0.3), ('b', 'c', 0.2), ('a', 'c', 0.6), ('c', 'd', 1.0)]$?

A.#0 ['a', 'b', 'c', 'd']   B.*2 ['b', 'c', 'd']   C.*1 ['a', 'b', 'c']

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Example with Matrix

#012 1. (35%) An entry $a_0 = (i, j)$ of a matrix is called **North lesser** if its value is lesser than the neighbouring ones positioned at a_8, a_1, a_2, as indicated in the following table. See left below an example $A = 7 \times 16$ and right below its corresponding **North lesser** entries, where "-" means "-1".

a_8 = Northwest	a_1 = North	a_2 = Northeast
a_7 = West	$a_0 = (i, j)$	a_3 = East
a_6 = Southwest	a_5 = South	a_4 = Southeast

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Example of Exam

- webMCTest
- All institutes
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- All disciplines
- All topics

- User: omitted
  - Questions
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See-PDF

Caution: (1) Choose A4 sheet with good toner. (2) For multiple-choice exams, if the circles are defective, the broker may not work correctly - we recommend that you change the printer and print again. (3) Before applying the exam, it is strongly recommended to print a sheet, fill in, scan and follow the step on the right side. Upload-PDF >>>

Escolher arquivo   Nenhum arquivo selecionado

Upload-PDF   Choose PDF file for correction of exams

Caution: (1) Before scanning, make sure all circles have been filled correctly. If you to use correction fluid and erase part of the outline of the circle, the correction may not work. (2) Scan with a resolution of 150dpi (if you can not decode QRCode, use 200dpi), gray levels, just the front of the sheet and one PDF per class. (3) The 4 black disks can not be defective. (4) If you chose only answers on the screen of this exam, the first page of the PDF should contain the template and all questions will be disregarded. (5) If in this Exam screen the option to Return to Students was chosen, when enrolling the students in the class, you must also include the student's e-mail. If this has been done, you can follow the step to the right side Send-Return-Students, for each student receive the correction of your examination by email >>>

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Example of Exam: See-PDF

- This QRcode contains both **encrypted** and **compressed** informations.
- It stores (ID) exam, class and student.
- And for **each question**, it contains the **order of the random answers**.

Example of Exam: correct PDF

- webMCTest
- All institutes
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- All disciplines
- All topics

- User: omitted
  - Questions
  - Classrooms
  - Exams

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http://nubisys.ufabc.edu.br:8000/exam/exam/1/update/ in English
http://vision.ufabc.edu.br:8000/exam/exam/50/update/ in Portuguese

See-PDF

Caution: (1) Choose A4 sheet with good toner. (2) For multiple-choice exams, if the circles are defective, the broker may not work correctly - we recommend that you change the printer and print again. (3) Before applying the exam, it is strongly recommended to print a sheet, fill in, scan and follow the step on the right side. Upload-PDF >>>

Escolher arquivo   Nenhum arquivo selecionado

Upload-PDF   Choose PDF file for correction of exams

Caution: (1) Before scanning, make sure all circles have been filled correctly. If you to use correction fluid and erase part of the outline of the circle, the correction may not work. (2) Scan with a resolution of 150dpi (if you can not decode QRCode, use 200dpi), gray levels, just the front of the sheet and one PDF per class. (3) The 4 black disks can not be defective. (4) If you chose only answers on the screen of this exam, the first page of the PDF should contain the template and all questions will be disregarded. (5) If in this Exam screen the option to Return to Students was chosen, when enrolling the students in the class, you must also include the student's e-mail. If this has been done, you can follow the step to the right side Send-Return-Students, for each student receive the correction of your examination by email >>>

Example of Exam: [scan PDF](#)

Pag	ID	Answ	Quest	Inv	Final	1	2	3	4	1	2	3	4
1	1	5	4	0	4	E	C	D	A	241230	541032	1143102	102431
2	2	5	4	2	0	A/B	2/A	A/B	0/D	110324	201342	530214	1141302

Conclusion

- Our solution helps answer the questions:
  - How to generate exams for many students?
    Traditional paper exams are required because
    online answers aren't reliable.
  - How to minimize fraud?
    An exams in which the questions are unique to each student.
  - How to correct exams automatically?
    With computer vision applied to the scanned image of the answer sheets.
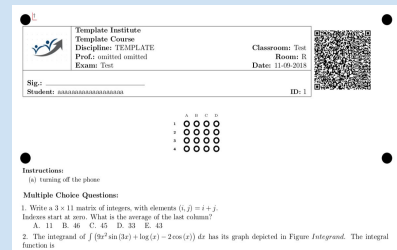
Pag	ID	Answ	Quest	Inv	Final	1	2	3	4	1	2	3	4
1	1	5	4	0	4	E	C	D	A	241230	541032	1143102	102431
2	2	5	4	2	0	A/B	2/A	A/B	0/D	110324	201342	530214	1141302

Future Works

- Using eLearning system
  - such as Moodle
- Create the views for the student monitoring
- Improve security, including facial and digital recognition in the QRCode

Thanks!

Questions?

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