Descrição do Problema e Primeira Agregação

January 5, 2021

[36]:
```
import pandas as pd
import seaborn as sn

import base_functions

pd.set_option('display.float_format', lambda x: '%.3f' % x)
```

1 Desafio

Dentre os desafios propostos, o escolhido foi:

- *"Como predizer o desempenho dos estudantes nas avaliações finais"*.

Cada estudante em cada módulo faz em média quatro provas, e a nota final consiste de uma média ponderada dessas notas, que define a aprovação ou não do estudante. Destarte, pode-se pensar em "avaliações finais" em dois níveis de agregação distintos: - primeiro é o de tentar prever o desempenho em cada prova, uma vez que não há uma avaliação final *per se*, e sim um conjunto de avaliações para cada módulo; - a outra interpretação possível é entender a avaliação final como a média das avaliações que é também o resultado final de desempenho.

Aqui utilizamos a segunda interpretação, por motivo de simplicidade e performance preditiva, uma vez que ambas foram testadas. Os testes e análises não foram exaustivamente incluídos nesse texto visando manter uma linha condutória com leitura mais fluída.

Pontuo também que o texto no formato markdown será feito em português, e os comentários relacionados as operações computacionais e feitos na forma de comentários no código serão feitos em inglês por convenção.

2 Entendimento dos dados

Essa seção consiste de três etapas: 1. Apresentação da descrição dos dados presente no link https://analyse.kmi.open.ac.uk/open_dataset.

2. Exposição dos dados e de algumas propriedades *e.g* cardinalidade.

3. Agregação dos diferentes datasets visando criar um dataset analítico inicial.

O banco de dados é organizado em sete diferentes tabelas, descritas na imagem acima. Descrevendo de forma simples, as tabelas são divididas nas que descrevem: - O estudante - Os módulos - As atividades no VLE (virtual learning environment).

O objetivo de agregação é criar uma tabela única que tenha como chave composta a triade [**Estudante | Curso | Semestre**]. Dessa forma, assume-se que o mesmo estudante, cursando cursos diferentes, ou o mesmo curso em outro momento do tempo será tratado de forma independente.

3 Descrição do problema, variáveis, e visualização dos dados de cada tabela

As descrições foram tiradas integralmente da página de referência.

Description ”This page introduces the anonymised Open University Learning Analytics Dataset (OULAD). **It contains data about courses, students and their interactions with Virtual Learning Environment (VLE) for seven selected courses (called modules)**. Presentations of courses start in February and October - they are marked by “B” and “J” respectively. The dataset consists of tables connected using unique identifiers. All tables are stored in the csv format.”

```
[21]: df_0 = pd.read_csv("../data/assessments.csv")
```

This file contains information about assessments in module-presentations. Usually, every presentation has a number of assessments followed by the final exam.

code_module – identification code of the module, to which the assessment belongs. **code_presentation** - identification code of the presentation, to which the assessment belongs. **id_assessment** – identification number of the assessment. **assessment_type** – type of assessment. Three types of assessments exist: Tutor Marked Assessment (TMA), Computer Marked Assessment (CMA) and Final Exam (Exam). **date** – information about the final submission date of the assessment calculated as the number of days since the start of the module-presentation. The starting date of the presentation has number 0 (zero). **weight** - weight of the assessment in %. Typically, Exams are treated separately and have the weight 100%; the sum of all other assessments is 100%.

```
[22]: df_0.head(3)
```

```
[22]:   code_module code_presentation  id_assessment assessment_type   date  weight
      0         AAA             2013J           1752             TMA   19.0    10.0
      1         AAA             2013J           1753             TMA   54.0    20.0
      2         AAA             2013J           1754             TMA  117.0    20.0
```

```
[8]: base_functions.describe_(df_0)
```

```
shape (206, 6)
#############
Contagem de categorias: code_module
FFF    52
BBB    42
```

```
DDD    35
GGG    30
CCC    20
EEE    15
AAA    12
Name: code_module, dtype: int64
#############
Contagem de categorias: code_presentation
2014J    57
2014B    57
2013J    53
2013B    39
Name: code_presentation, dtype: int64
#############
Contagem de categorias: assessment_type
TMA     106
CMA      76
Exam     24
Name: assessment_type, dtype: int64
```

[10]:

```
df_1 = pd.read_csv("../data/courses.csv")
```

File contains the list of all available modules and their presentations. code_module – code name of the module, which serves as the identifier. **code_presentation** – code name of the presentation. It consists of the year and "B" for the presentation starting in February and "J" for the presentation starting in October. **length** - length of the module-presentation in days. The structure of B and J presentations may differ and therefore it is good practice to analyse the B and J presentations separately. Nevertheless, for some presentations the corresponding previous B/J presentation do not exist and therefore the J presentation must be used to inform the B presentation or vice versa. In the dataset this is the case of CCC, EEE and GGG modules.

[7]:

```
df_1.head(3)
```

[7]:

```
  code_module code_presentation  module_presentation_length
0         AAA             2013J                         268
1         AAA             2014J                         269
2         BBB             2013J                         268
```

[11]:

```
base_functions.describe_(df_1)
```

```
shape (22, 3)
#############
Contagem de categorias: code_module
BBB    4
FFF    4
DDD    4
EEE    3
GGG    3
```

```
AAA    2
CCC    2
Name: code_module, dtype: int64
#############
Contagem de categorias: code_presentation
2014J    7
2014B    6
2013J    6
2013B    3
Name: code_presentation, dtype: int64
```

[14]:

```
# join df_0 and df_1
df_0_1 = df_0.merge(df_1, on=['code_module', 'code_presentation'])
```

[12]:

```
df_2 = pd.read_csv("../data/studentAssessment.csv")
```

This file contains the results of students' assessments.

If the student does not submit the assessment, no result is recorded. The final exam submissions is missing, if the result of the assessments is not stored in the system. This file contains the following columns: **id__assessment** – the identification number of the assessment. **id__student** – a unique identification number for the student. **date__submitted** – the date of student submission, measured as the number of days since the start of the module presentation. **is__banked** – a status flag indicating that the assessment result has been transferred from a previous presentation. **score** – the student's score in this assessment. The range is from 0 to 100. The score lower than 40 is interpreted as Fail. The marks are in the range from 0 to 100.

[11]:

```
df_2.head(3)
```

[11]:

```
   id_assessment  id_student  date_submitted  is_banked  score
0           1752       11391              18          0   78.0
1           1752       28400              22          0   70.0
2           1752       31604              17          0   72.0
```

[13]:

```
df_2.shape
```

[13]:

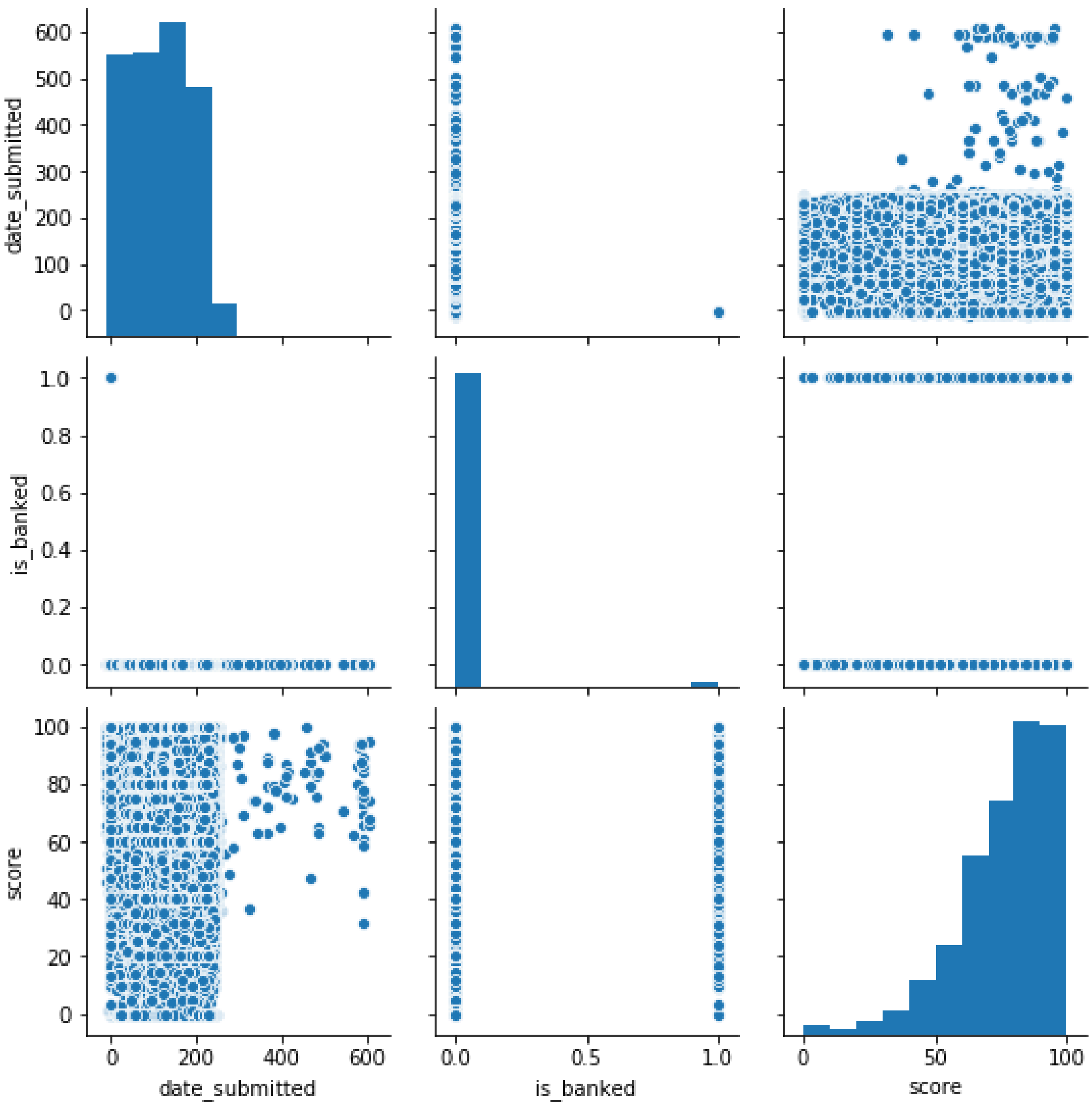
```
(173912, 5)
```

[26]:

```
sn.pairplot(df_2.drop(columns=['id_assessment', 'id_student']))
```

[26]:

```
<seaborn.axisgrid.PairGrid at 0x7f2906657898>
```



```
[49]: # join df_2 with the previous two.
      df_0_1_2 = df_2.merge(df_0_1, on = ['id_assessment'])
```

```
[48]: df_3 = pd.read_csv("../data/studentInfo.csv")
```

This file contains demographic information about the students together with their results. code__module – an identification code for a module on which the student is registered. **code__presentation** - the identification code of the presentation during which the student is registered on the module. **id__student** – a unique identification number for the student. **gender** – the student's gender. **region** – identifies the geographic region, where the student lived while taking the module-presentation. **highest__education** – highest student education level on entry to the module presentation. **imd__band** – specifies the Index of Multiple Depravation band of the place where the student lived during the module-presentation. **age__band** – band of the student's age. **num_of_prev_attempts** – the number times the student has attempted this module. **studied_credits** – the total number of credits for the modules the student is currently studying. **disability** – indicates whether the student has declared a disability. **final_result** – student's final result in the module-presentation.

[13]:
```
df_3.head(3)
```

[13]:
```
  code_module code_presentation  id_student gender               region  \
0         AAA             2013J       11391      M  East Anglian Region
1         AAA             2013J       28400      F             Scotland
2         AAA             2013J       30268      F North Western Region

      highest_education imd_band age_band  num_of_prev_attempts  \
0       HE Qualification  90-100%     55<=                     0
1       HE Qualification   20-30%    35-55                     0
2 A Level or Equivalent   30-40%    35-55                     0

  studied_credits disability final_result
0             240          N         Pass
1              60          N         Pass
2              60          Y    Withdrawn
```

[37]:
```
desc(df_3)
```

```
shape (32593, 12)
code_module
BBB    7909
FFF    7762
DDD    6272
CCC    4434
EEE    2934
GGG    2534
AAA     748
Name: code_module, dtype: int64
code_presentation
2014J    11260
2013J     8845
2014B     7804
2013B     4684
Name: code_presentation, dtype: int64
gender
M    17875
F    14718
Name: gender, dtype: int64
region
Scotland                3446
East Anglian Region     3340
London Region           3216
```

```
South Region            3092
North Western Region    2906
West Midlands Region    2582
South West Region       2436
East Midlands Region    2365
South East Region       2111
Wales                   2086
Yorkshire Region        2006
North Region            1823
Ireland                 1184
Name: region, dtype: int64
highest_education
A Level or Equivalent          14045
Lower Than A Level             13158
HE Qualification                4730
No Formal quals                  347
Post Graduate Qualification      313
Name: highest_education, dtype: int64
imd_band
20-30%     3654
30-40%     3539
10-20      3516
0-10%      3311
40-50%     3256
50-60%     3124
60-70%     2905
70-80%     2879
80-90%     2762
90-100%    2536
Name: imd_band, dtype: int64
age_band
0-35     22944
35-55     9433
55<=       216
Name: age_band, dtype: int64
disability
N    29429
Y     3164
Name: disability, dtype: int64
final_result
Pass           12361
Withdrawn      10156
Fail            7052
Distinction     3024
Name: final_result, dtype: int64
```

```
[ ]:
```

```
[50]: # join df_3 with the previous three.
      df_0_1_2_3 = df_0_1_2.merge(df_3, on=['code_module', 'code_presentation',␣
       ↪'id_student'])
```

```
[ ]:
```

```
[51]: df_4 = pd.read_csv("../data/studentRegistration.csv")
```

This file contains information about the time when the student registered for the module presentation. For students who unregistered the date of unregistration is also recorded. **code_module** – an identification code for a module. **code_presentation** - the identification code of the presentation. **id_student** – a unique identification number for the student. **date_registration** – the date of student's registration on the module presentation, this is the number of days measured relative to the start of the module-presentation (e.g. the negative value -30 means that the student registered to module presentation 30 days before it started). **date_unregistration** – date of student unregistration from the module presentation, this is the number of days measured relative to the start of the module-presentation. Students, who completed the course have this field empty. Students who unregistered have Withdrawal as the value of the final_result column in the studentInfo.csv file.

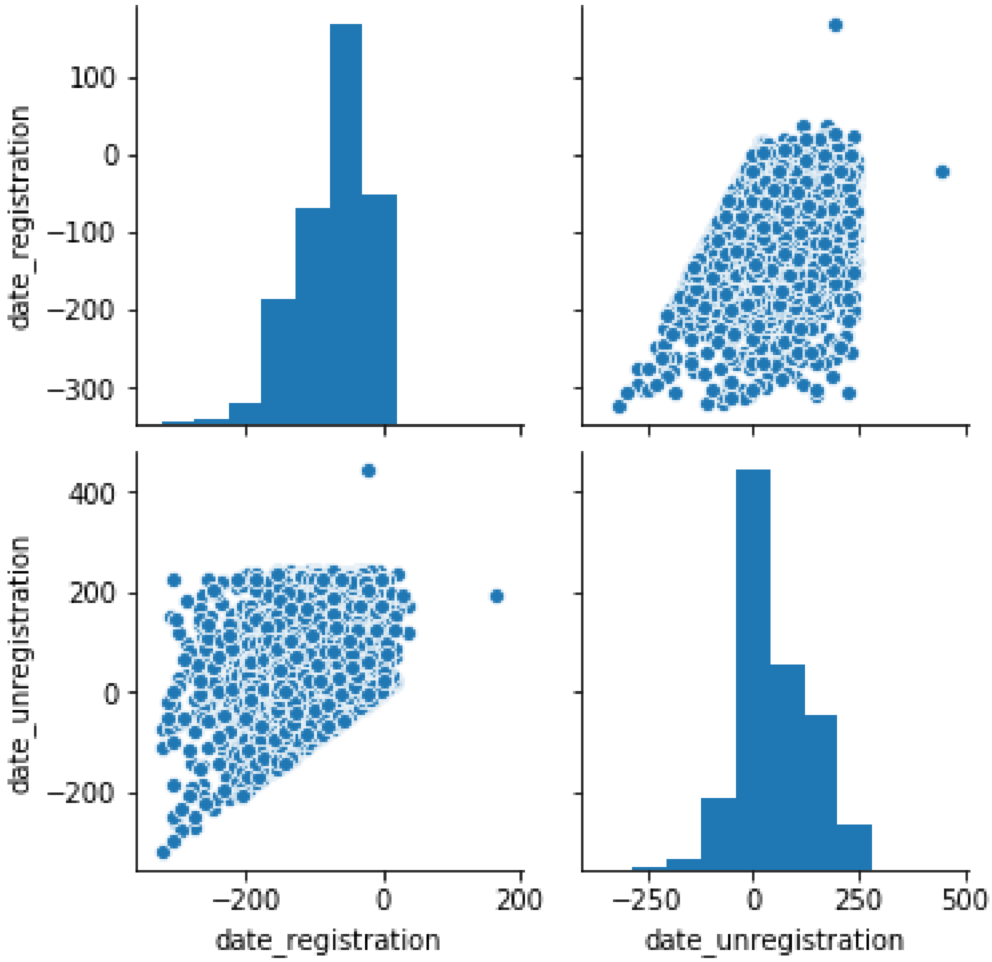
```
[15]: df_4.head(3)
```

```
[15]:   code_module code_presentation  id_student  date_registration  \
      0         AAA             2013J       11391             -159.0
      1         AAA             2013J       28400              -53.0
      2         AAA             2013J       30268              -92.0

         date_unregistration
      0                  NaN
      1                  NaN
      2                 12.0
```

```
[29]: sn.pairplot(df_4.drop(columns=['id_student']))
```

```
[29]: <seaborn.axisgrid.PairGrid at 0x7f28fe8ae128>
```



```
[ ]:
```

```
[52]: # join df_4 with the previous four.
df_0_1_2_3_4 = df_0_1_2_3.merge(df_4, on=['code_module', 'code_presentation',␣
 ↪'id_student'])
```

```
[53]: df_5 = pd.read_csv("../data/studentVle.csv")
```

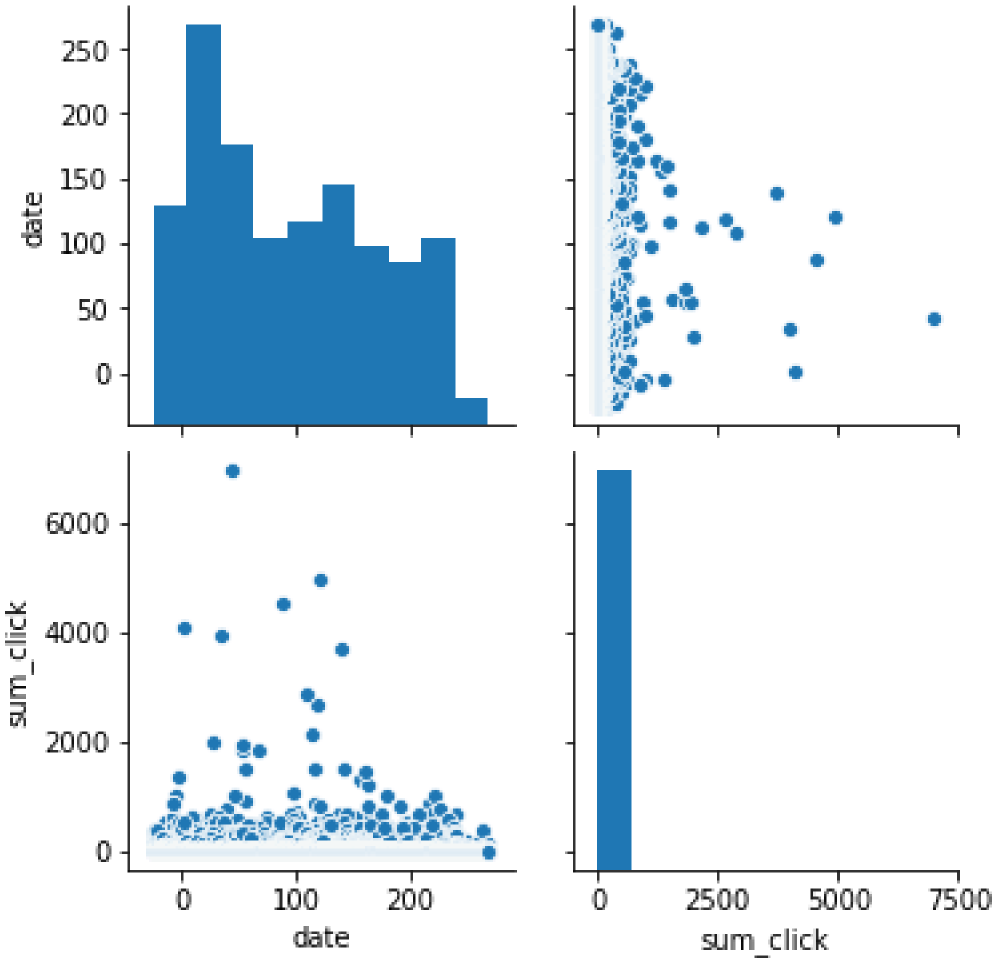
The studentVle.csv file contains information about each student's interactions with the materials in the VLE. (virtual learning environment) code_module – an identification code for a module. **code_presentation** - the identification code of the module presentation. **id_student** – a unique identification number for the student. **id_site** - an identification number for the VLE material. **date** – the date of student's interaction with the material measured as the number of days since the start of the module-presentation. **sum_click** – the number of times a student interacts with the material in that day.

```
[17]: df_5.head(3)
```

```
[17]:   code_module code_presentation  id_student  id_site  date  sum_click
     0          AAA             2013J       28400   546652   -10          4
     1          AAA             2013J       28400   546652   -10          1
     2          AAA             2013J       28400   546652   -10          1
```

```
[32]: sn.pairplot(df_5.drop(columns=['id_site', 'id_student']))
```

```
[32]: <seaborn.axisgrid.PairGrid at 0x7f28fe9c6e10>
```



```
[37]: df_5['sum_click'].describe()
```

```
[37]: count    10655280.000
      mean            3.717
      std             8.849
      min             1.000
      25%             1.000
      50%             2.000
```

```
75%             3.000
max          6977.000
Name: sum_click, dtype: float64
```

[54]:

```
# Here we separete just the sum_click variable, which is the one that keeps a
#  meaningful interpretation after agreggation. We could easily perform this␣
 ↪agreggation on the
#   next step of the analysis instead of now.
grouped_df_5 = df_5.drop(columns=[
    'id_site', 'date']).groupby(
     by=['code_module', 'code_presentation', 'id_student']
     ).sum().reset_index()

# Here we agregate the df_5 with all the previous.
df_0_1_2_3_4_5 = df_0_1_2_3_4.merge(
    grouped_df_5, on=['code_module', 'code_presentation', 'id_student'])
```

[18]:

```
df_6 = pd.read_csv("../data/vle.csv")
```

The csv file contains information about the available materials in the VLE. Typically these are html pages, pdf files, etc. Students have access to these materials online and their interactions with the materials are recorded. id__site – an identification number of the material. **code__module** – an identification code for module. **code__presentation** - the identification code of presentation. **activity__type** – the role associated with the module material. **week__from** – the week from which the material is planned to be used. **week__to** – week until which the material is planned to be used.

[19]:

```
df_6.head(3)
```

[19]:

```
   id_site code_module code_presentation activity_type  week_from  week_to
0   546943         AAA             2013J      resource        NaN      NaN
1   546712         AAA             2013J     oucontent        NaN      NaN
2   546998         AAA             2013J      resource        NaN      NaN
```

[76]:

```
df_6.shape
```

[76]:

```
(6364, 6)
```

[15]:

```
# I chose to not include the df_6 in the analytical df, since I understand that␣
 ↪the activity
#  type var couldn't be grouped by student, and the week_from and week_to have␣
 ↪no simple
#   interpretation once we group the data for each student.
```

3.0.1 Exportação do primeiro dataset analítico.

```
[98]: df_0_1_2_3_4_5.to_csv('base_data.csv', index=False)
```