CONSTRUCTION OF A WORD BAG MODEL TO DETECT PLAGIARISM IN THE MATLAB LANGUAGE

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ABSTRACT

A method is presented for building a word bag by extracting tokens from Matlab-coded programs, where each token is labeled according to a value that is assigned as the file is read, and its value varies according to the number of times it is in the program. The levels of plagiarism type 1, 2 and 3 are mainly analyzed, since they are the most used in the academic field. The results show that plagiarism can be detected with programs when using Level 2.

KEYWORDS: Plagiarism, Matlab, bag of words, histogram of words

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1. INTRODUCTION

The copyright allows to protect different documents and works, avoiding the economic loss that entails to the authors and companies that have developed the products. From the academic point of view, we try to avoid based on academic recommendations or sanctions. Plagiarism can be classified according to Rojas (2012) as: direct, inadequate use of paraphrases, complex using some reference, loose quotes, paraphrasing, self-plagiarism; the latter is committed when the appearance of a work is changed and it is presented as if it were another one. In this context, there is software (De La Cruz Vargas et al., 2016; Kashkur, Parshutin, y Borisov, 2010; Shkodkina y Pakauskas, 2017) that can detect plagiarism in documents such as: plagium, Turniti, PlagScan; which are based on vector space models, word bags, local and global structure, as well as semantic aspects (Sánchez-Vega, 2016). The above tools can be effective if they analyze Word style documents, but they are not very efficient when analyzing source code of programming languages; the main reason is that two words in a text are the same when written identically, but in programming they can be different but they are the same words or variables defined by the programmer. To detect plagiarism in a program is used the method of bags of words (BOW) which is to determine the number of tokens ignoring the order in the program and can be classified detection in 7 levels (Picazo-Alvarez, Villatoro-Tello, Luna-Ramírez, y Jaimez-González, 2014): change of expressions, program instructions, combination of functions, position of variables, change of identifiers, change of comments and no change - exact copy.

The work in this field is not only based on the source code but also on the suspicious behavior of each student (Ljubovic y Pajic, 2020)e.g. using and saving in the cloud data of each student when analyzing the number of compilations, the length of the program, the deleted and modified lines, and the time in making a program are parameters that can attract attention when there are values that are outside the normal data of a programmer. It is also possible to extract the tokens of each program and find a match with different languages, this can happen when using a program which is taken to another language in such a way that the plagiarism goes unnoticed (Karnalim, 2020). Also

Karnalim (2017) proposes that with 35 characteristics you can find acceptable results and found that the most used characteristics were the change of messages and blank spaces with a high total of attacks in the Python language.

Due to the complexity of detecting plagiarism in a programming language, most tools work exclusively with one language; that's why we propose language independent libraries as plagiarism (Francinton y Karnalim, 2019), where you try to order the tokens you find in different positions by means of three panels: the first and second panels show the repeated lines and the last one the amount found, with results that allow to serve as an assistant to reduce the tasks of code observation.

N-grams are used as probabilities to find matching tokens (Burrows y Tahaghoghi, 2007; Jimenez, Cordy, Le Traon, y Papadakis, 2018) and are used to achieve high efficiency in plagiarism control). BOW-based methods allow the use of statistics to find similar instructions, and consists of extracting the amount of tokens and grouping them into a given value using a histogram (Zhang, Jin, y Zhou, 2010).

The objective of this work is the construction of a BOW-based model that allows the identification of plagiarism in Matlab-coded programs by tagging the tokens for statistical analysis.

2. METHODOLOGY

When analyzing the levels of complexity of plagiarism in a program we find the 7 levels proposed by Faidhi and Robinson (1987) of which the methodology tries to find fraud on levels 1, 2 and 3 which are the most used by students with little knowledge of programming (see Figure 1).

Figure 1: Complexity levels of plagiarism (Picazo-Alvarez et al., 2014, p. 47).

The level 1 is the change of comments and is where most changes are detected when using a source code that is not of own authorship; while the change of identifiers is used by most students with little knowledge in the program and the position of variables is made by expert programmers who try to pass the program through a new one.

2.1 Token Extraction

Each token is extracted from the program code and stored in a cell array, in Figure 2 an example of code is shown and in table 1 you can see how it is stored in the cell array.

```
if ca==0
    return;
end
```

```

constru=fullfile(da,ca);

load (constr);

routes2{1,1}=[];

routes2{1,2}=[];

numeric= oc;

for fill=1:numeric

    pal=num2str(fill);

    if isempty(routes2{1,1})

        rutas2{1,1}=rutas{1,2}'

    else

        rutas2{1,1}=[rutas2{1,1};
rutas{llenar,2}'];

    end

end

```

Figure 2: Source code 1.

Table 1: Token Removal

Index	Tokens	Line
1	if	1
2	ca	1
3	Return	2
4	End	3
5	Constru	4
6	Fullfile	4
7	Give	4
8	ca	4
9	Load	5
10	Constru	5
11	Routes2	6
12	Routes2	7
13	Numerical	8
14	Oc	8
15	For	9
16	Fill out	9
17	Numerical	9
18	Pal	10
19	Num2str	10
20	Fill out	10
21	If	11

22	isempty	11
23	Routes2	11
24	Routes2	12
25	Routes	12
26	Else	13
27	Routes2	14
28	Routes2	14
29	Routes	15
30	Fill out	16
31	End	17
32	End	18

Any source code is done with the same extraction as above.

2.2 Token labels

Each one of the reserved words or variables used is labeled, if any of them is repeated only the first one is labeled, remaining as shown in table 2.

Table 2: Labels

Label value	Tokens
1	if
2	ca
3	Return
4	End
5	Constru
6	Fullfile
7	Give
8	Ca
9	Load
10	Routes2
11	Numerical
12	Oc
13	For
14	Fill out
15	Pa1
16	Num2str
17	Isempy
18	Routes
19	Else

2.3 Construction of BOW

The BOW is constructed by counting the number of times that a word is repeated taking into account the value of the label, if we select IF, END, ROUTES2 and NUMERICAL we can see that it creates a histogram with the number of times it appears (See Fig. 3). Finally, a table is built with the quantification and number of times of each token, so later we can apply the correlation with another program (see Table 3).

IF		END		ROUTES2	Numerical

Figure 3: Number of times of tokens

Table 3: BOW Construction

Label value	Tokens	Quantity
1	if	2
2	ca	1
3	Return	1
4	End	3
5	Constru	2
6	Fullfile	1
7	Give	1
8	Ca	1
9	Load	1
10	Routes2	6
11	Numerical	2
12	Oc	1
13	For	1
14	Fill out	3
15	Pa1	1
16	Num2str	1
17	Isempty	1
18	Routes	2
19	Else	1

To compare the effectiveness of the method, three source codes that presented the same solution to the problem were compared and the correlation between them was made. Because the codes did not resemble each other by changing the name of variables, an overlap was made so that the variables were changed to var1, var2, var3, etc. While the reserved words were left with the same extraction token.

3. RESULTS

The 3 codes were overlapped, for example code 1 is represented by table 4, where we can replace the tokens by other tokens that allow an equality between the tokens of other programs.

Table 4: BOW Overlay

Label value	Tokens	Quantity
1	if	2
2	VAR1	1
3	Return	1
4	End	3

5	VAR2	2
6	Fullfile	1
7	VAR3	1
8	VAR4	1
9	Load	1
10	VAR5	6
11	VAR6	2
12	VAR7	1
13	For	1
14	VAR8	3
15	VAR9	1
16	Num2str	1
17	Isempty	1
18	VAR10	2
19	Else	1

In this way it is not interesting to make changes to the identifiers since by superimposition you will find those that are repeated using correlation.

In Figure 4 you can see the program code 2, although a change of level 2 has been made by the students the program will detect it because the BOW will end up being the same

```

if m==0
    return;
end
armar=fullfile(xx,yy);
load (assemble);
via{1,1}=[];
via{1,2}=[];
z= two;
for max=1:z
    a1=num2str(max);
    if isempty(via{1,1})
        via{1,1}=cambio{1,2}'
    else
        via{1,1}=[via{1,1};
cambio{max,2}'];
    end
end
end

```

Figure 4: Source code 2

When you compare the instruction of code 1 with that of code 2 you will find that they are identical (see Figure 5)

Figure 5: Level 2 plagiarism.

In table 5, it can be determined that programs 1 and 2 maintain a correlation of 1 with which is level 2 plagiarism and there is also level 6 plagiarism because they end up changing expressions (Equation 1). Between program 1 and 2 there is no correlation with program 3 so no level plagiarism has been found (see table 5).

$$\rho(A, B) = \frac{1}{N-1} \sum_{i=1}^N \left(\frac{A_i - \mu_A}{\sigma_A} \right) \left(\frac{B_i - \mu_B}{\sigma_B} \right) \quad (1)$$

Table 5: Correlation

1	1	0.23
1	1	0.14
0.23	0.14	1

4. CONCLUSIONS

The construction of a bag of words and the quantification by replacing the identifiers of each program by common identifiers allows to determine when there is level 2 plagiarism, independently if the programmer has changed the identifiers, so that plagiarism can be found among programs submitted by students who try to submit a program totally or partially without being the author. It is only determined when the programs have been changed by level 2, and the level 1 belonging to the interface change has not been determined.

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