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TOPIC MODELING AND SENTIMENT ANALYSIS IN FACEBOOK TO ENHANCE STUDENTS' LEARNING

TAOUFIQ ZARRA*, RADDOUANE CHIHEB, RDOUAN FAIZI, ABDELLATIF EL AFIA
Mohammed V University in Rabat, Morocco
taoufiq.zarra@um5s.net.ma*, chiheb@ensias.ma, faizi@ensias.ma, elafia@ensias.ma

ABSTRACT

Information and communication technologies (ICT) have changed our daily lives and have particularly influenced the field of education, revolutionizing the means of teaching and learning. This article focuses mainly on the blended learning, whose on-site, lessons are devoted to the essential matter offered to the learners; and the ICT are used for a deep learning. We will use the collective intelligence that is shared on social websites such as Facebook in order to create learning groups. To make this objective possible, we will base our work on the generative probabilistic model of Latent Dirichlet Allocation. We will use this model on all the discussions shared between learners and between learners and teachers to classify students according to the topics and the difficulties that each one of them has expressed; in order to help the teachers build new knowledge on the degree of assimilation of students

Keywords: *Sentiment analysis, Latent Dirichlet Allocation, Learning, Facebook*

1. INTRODUCTION

Besides the great aim achieved by the information and communications technologies (ICT) which are making education accessible world widely, the emergence of digital tools (web 2.0) was revolutionary for the traditional school model; the traditional teaching tools fade away slowly and learning can be provided at any time by a simple click. Thus, it is necessary to use ICT: to implement a high quality learning and education, a professional development for teachers and an efficient management, governance and educational administration. The concept that we will develop in this article is to use as much as possible collective intelligence developed by students and teachers (outside the class, in written exchanges) to spend more time on learning. We notice indeed that the traditional education system suffers from lack of time, teachers are forced to assume that students have understood all the content provided and pass to the next unit and face difficulties to consider the questions of each student. Thus, students have to dedicate a part of the time spent outside school for internet research, communication and consolidation of knowledge. On the other hand, teachers need the means to measure students' progress and performances and establishing an early diagnosis of problems faced by their students.

Launched in 2004, Facebook has quickly become an ecosystem that is part of our life. In the beginning Facebook's objective was to group students from American universities, but now it affects the entire world's population, including the field of education. Since Facebook has structurally changed the way we see the relationships between teachers and students; the border deleted between persons' private life and public life has simplified the communication between teachers and students .Far from using Facebook because it attracts students, social networks have become the most used media in digital practices, and the information learned via these networks is an in-depth knowledge because students are always invited to contribute. For this reason the research question we addressed in the paper is how to make beneficial use of the pertinent information that students leave on social networks, namely Facebook when discussing different educational issues and topics; in order to achieve this goal, we adapted a probabilistic generative model to explain the observations: Latent Dirichlet Allocation or LDA, which consist on extracting all the discussions, in order to deduct interests, expectations or problems faced by students to help teachers establishing diagnostics, developing solutions or deducting applicable rules for similar cases.

Our article is organized as follows: Section 2 introduces works on how to use social networks (such as Facebook) for education. Section 3

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describes the probabilistic model LDA; we will present the integration of opinion and sentiment parameter in the model. Section 4 describes the structure that we propose to create learning groups through discussions on Facebook. Section 5 presents all the experiments conducted. And in section 6 we conclude this study and we introduce future work in this subject.

2. RELATED WORK AND HYPOTHESES OF THIS STUDY

The discussions between students or between students and teachers on forums, which help clarifying ideas, sharing opinions, developing common language and solutions, promote the development of a promising new educational model where students can control their learning and the transmission of knowledge is no longer diagonal, i.e. from the teacher to the students, but it is rather collaborative where all actors are invited to build and strengthen their knowledge.

Several studies show the importance of written communication as an educational potential in the development of knowledge. The writing exercise for a student is indeed considered more precise and rigorous because it needs more time of research, precision and reflection than an oral exchange [1]; the attractiveness of the forum is due to the fact that members focus particularly on the content. The absence of social indicators, the look and the physical presence of the teacher build a peaceful atmosphere where students exchange self-critical messages, oriented towards sharing rather than competition that characterizes oral exchange in class.

The first generation of forums which is characterized by a brief exchange limited in time and space, a quick "question-answer" type instead of an in-depth exchange, is considered less interesting for students, and the forum end up vanishing quickly [2, 3, and 4]. However, based on the standards that students learn more effectively if they are encouraged to participate in collaborative or problem solving activities [6 and21]; the last decade has seen the emergence of a new type of learning based on the "social media", although several studies have shown that social networks are often used in a more personal way rather than used for a learning objective [9and 10] with a negative impact on some students as specified in [13] where Facebook users have lower grades than non-users since they spent more time on Facebook than in learning. Other researchers have exposed the influence of social networks in students' learning experience, with an average of more than 30 minutes passed every day on Facebook [9 and 7], the students mainly use it to keep in touch with their classmates and share ideas on projects and discuss the lecture notes; and used by teachers to transmit information and instruction to students or in other cases help students feel more comfortable asking questions on Facebook rather than in class [8]. Other categories of research, [11, and14] have found that students who use Facebook develop a capital and social trust and a creative talent more important than students who do not use it. Other articles went further in their propositions using Facebook groups as a Learning Management System (LMS) [15], students use their profile data in the same way that an LMS does where it is required to use a login and password, and thanks to the range of tools offered by Facebook, students can create, manage, organize and share content, offer answers questions or use the discussion platforms as a space for exchange as a traditional LMS [17].Other researches focused on the relationship that may exist between teachers and students on Facebook and its impact on the educational experience of students [18,19 and 20].

In this article, unlike other previous given, we are particularly interested on all content shared between students on Facebook with the objective of:

- Identify and describe the nature of exchanges that can exist between students, between students and teachers or between teachers and teachers on Facebook
- Classify students and the exchanged data based on probabilistic and linguistic characteristics of the shared text. The Following hypotheses were made:
    - H1: teachers share in open groups' course notes, orientations and instruction for their students.
    - H2: students use publicly and freely their personal accounts to comment on the course, course notes or group work.

3. THEORETICAL FRAMEWORK

In this section we introduce the model Latent Dirichlet Allocation (LDA), first we will describe briefly the theoretical model and the integration of the sentiment variable in scheme then we will adapt the model for Facebook in a learning context.

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3.1. Topic Model

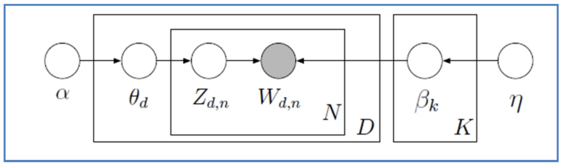

Figure 1: Graphical Model of LDA.

To identify all the topics in the discussion, there are several methods (Unigram Model, Mixture unigram model, the probabilistic latent semantic Indexing [16]), in this article we study Latent Dirichlet Allocation which is an unsupervised learning machine technique which identifies latent topic information in large document collections [22]. The approach uses the "bag of words" model which assumes that any document can be ²represented as a vector of word. A corpus is therefore represented by a vector matrix. For each document there is a multinomial distribution over topics, and a Dirichlet prior Dirichlet(α)is introduced, on such distribution. For each topic, there is another multinomial distribution over words.

- A corpus is a collection of documents $D = (w_1, w_2, \dots, w_D)$
- The variables $z_{d,n}$ represent the chosen topic for the word $w_{d,n}$
- The parameters θ_d represent the distribution of the document's topics
- α and η define the a priori distributions on θ and β respectively, where β_k describes the distribution of the topic

The LDA model can be represented graphically, Figure 1 [22]:

The generative process of LDA is that for a w document in a corpus D:

- Choose Dirichlet (α).
- For each word w_n:
- Select a Topic $z_n \sim \text{Multinomial}(\theta)$
- Then choose a word $w_n \sim \text{Multinomial}(\beta_k)$ with $k = z_n$

3.2. Sentiment Analysis

Sentiment analysis usually refers to the process of extracting opinions or sentiments from unstructured textual documents [23].

The opinion or sentiment may be described by a quadruple (1):

$$(O_j, f_{jl}, SO_{ii}, h_i, t_l) \quad (1)$$

- Polarity: positive, negative or neutral, which determines whether the opinion is favorable or unfavorable (SO_{ii})
- Who: the source or opinion holder (h_i).
- What: the opinion target object (O_j)
- Or the object function (f_{jl})
- Time: the time in which the opinion is expressed (t_l)

Two wide approaches are used to identify the text tonality: lexicon based method and machine learning approach.

The primary objective of the work on machine learning approach is to classify opinions and sentiments according to a trained corpus; the analysis of sentiment and opinion mining is usually considered as a classification problem where the categories are positive, negative or neutral. On the other hand, the work that is developed on the lexicon-based approach is draw upon the use of sentiment lexicons; the work around the lexicon based strategy is based on the use of sentiment lexicons.; the main concern of these methods is to let the document categorization without a trained corpus, the lexicon is likened to extract, assigning a score to each existence of sentiment terms, and it finally calculates an average score for the text.

4. SYSTEM DESIGN

The system that we are proposing can be represented by steps: A, B and C (Figure 2)

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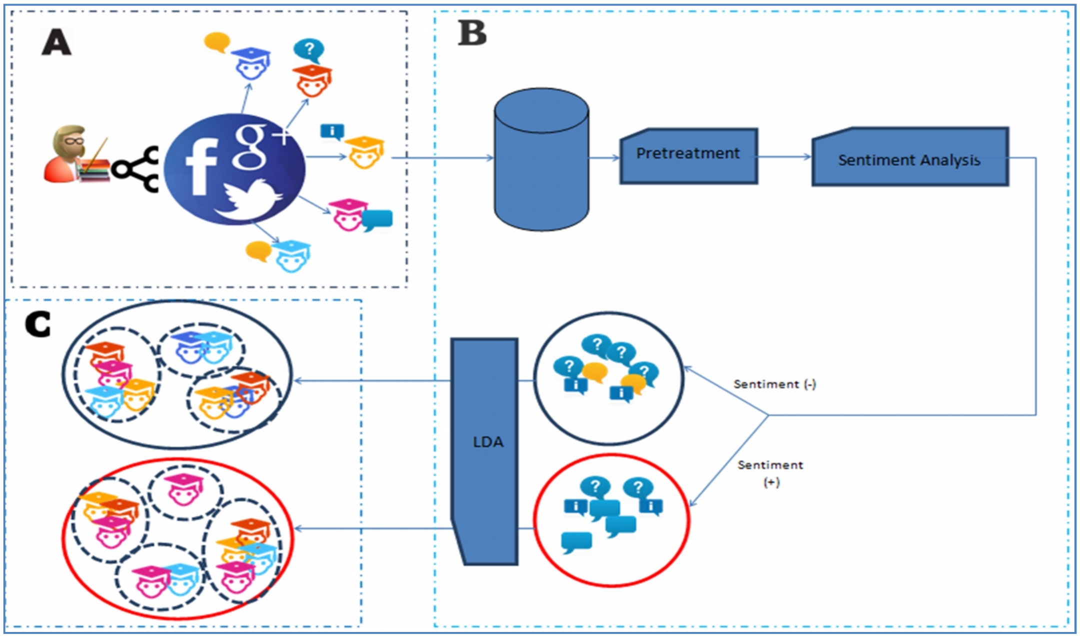

Figure 2 : Graphical Model of Sentiment analysis and LDA in Facebook.

4.1. Facebook an exchange platform: A

Facebook is a social network that is used to connect people and where people can share and exchanged information, chat in groups or individually, or establish a personal or professional relationship.

We are over 400 million Facebook users, and with a global population that is increasing on the internet. Facebook and other similar social networks grow exponentially; this is a success that is due to the community aspect which characterizes the website and the fact that everyone is or wants to be part of it. The learning community, among others, makes no exception; several activities to academic purposes are explained:

- Logistical and organizational: students can share easily courses, accommodation, dates, reviews schedules ...
- Storage and file sharing between students or between teachers and students.
- A space to facilitate discussions, question-answers, project groups ...
- A tool for scientific monitoring: students and teachers can share other resources found on the Internet, provide useful links to develop knowledge.

Our research is limited to the use of Facebook as an exchange forum between students or between students and teachers, it is the most visited website for discussion among students, and the debates undertaken are more interesting, more active, deep, sharp, and discuss more complicated topics.

We assume that teachers create Facebook groups for each class and:

- The access to the group is closed after students registration
- The teachers are invited to share educational resources available: courses, video tutorials, surveys...
- Students are encouraged to comment on the posts, ask questions, and propose adjustments or improvements of the contents, learning materials, assignments, exams, and many others.

Our aim is to consolidate and extract the entire topics discussed among students in order to classify them, we are not interested in the technical aspect of the discussions: if it is a comment on the post or a reply to a comment... but rather than that we handle comments related to a course unit in “bag of comments” the extracted information are classified in the following types:

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- Post shared by the teacher: *Post*
- Students' comments on the post: *Comment*
- Students participating in the discussion: *Student*
- The publication dates of the post and comments: *Time*

4.2. Extraction and analysis of the shared text: B

At this stage we can distinguish three sub-steps:

4.2.1. Extraction and pretreatment

First we use the Facebook API available for download to extract all comments; at this stage a set of pre-processing is necessary to prepare the text:

- Tokenization and Steaming: The operation can transform the text into a set of words, and reduce it to its root form or stem by removing all possible affixes
- Removal of empty words: Some words have no useful information for the analysis of the text, it is necessary to delete them to reduce the sentences of full words.

4.2.2. Classification opinions and sentiments

Since we focus on the difficulty and the degree of difficulty faced by students; comments on Facebook can be categorized into: fact and sentiment, a fact when a student shares information with his classmates or teachers and sentiment when a student shares a positive or negative sentiment about a course or a course unit which reflects a difficulty or a gap.

We identify two classes of sentiments: the "positive" class equivalent for us to the "strong point" that teachers must value their students for, and the "negative" class equivalent to the "weak point" that must be treated with students. There are many utilized algorithms such as: Support vector machine (SVM), Maximum Entropy (ME)… then the coming part of this article is going to be about the Naive Bayes method.

Naive Bayes algorithms are linear classifiers which they are known to be simple and effective. The classifiers probabilistic model of the naive Bayes method is based on the Bayes' theorem [24] and the naive adjective comes from the hypotheses of independence assumptions between the features.

Given a set of variable $F = \{F_1, F_1, .., F_d\}$ and our goal is to construct the posterior probability for the event C_j among a set of possible outcomes $C = \{C_1, C_1, .., C_d\}$ using Bayes' rule we can write:

$$p(C_j|F_1, F_2 \dots, F_d) \propto p(F_1, F_2 \dots, F_d|C_j)p(C_j) \quad (2)$$

Where $p(Cj|F_1, F_2 \dots, F_d)$ is the posterior probability of class membership, i.e., the probability that F belongs to C_j

We can decompose the likelihood to a product of terms:

$$p(F|C_j) \propto \prod_{k=1}^{d} p(F_k|C_j) \quad (3)$$

And rewrite the posterior as:

$$p(C_j|F) \propto p(C_j) \prod_{k=1}^{d} p(F_k|C_j) \quad (4)$$

Using Bayes' rule above, we label a new case F with a class level C_j that achieves the highest posterior probability.

In our case, the maximum likelihood probability of an n-gram belonging to a particular class (positive or negative) is given:

$$p(F_k|C) = \frac{\text{T fı o o o tl n−g iı tl cᵢ c}}{\text{tl su o tl fı o a tl n−g iı cᵢ c}} \quad (5)$$

4.2.3. Topic modeling on discussions

From the previous steps we can distinguish and classify comments and thus students who share positive and negative sentiments that probably means strong or weak points. The Topic Modeling stage will help subsequently extracting all Topics discussed, a student who shares "negative i.e. weak points" comment for example on the keywords "components", "user interface", "class diagrams"," XML Metadata"... is a student who has difficulty in "UML".

The Latent Dirichlet Allocation is a generative probabilistic model; its aim is to consider documents (Facebook comments) as random mixtures on topics (courses or course unit which has gaps for students) underlying, where each topic is characterized by a distribution on words.

4.3. Students' grouping: C

Thanks to the teacher's pedagogical methods, the teacher can develop a better supervision: an individualized teaching approach or a teaching method based on dividing students into subgroups. The previous stages of our approach allows these teachers to distinguish more easily students that have difficulties, which will help him after to gather them according to the topic discussed and identify

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the problem, the teacher can also plan, organize and manage the supervisory measures associated with this topic, he may devote his free time in the class , in the office or on the internet (including social media) to allow students consulting him about the lecture and show them new resources and methods to assimilate the course, such as videos, diagrams...

The approach presents six types of typology of interventions:

- Prevention: teachers can offer complementary activities to avoid future difficulties for students.
- Detection: representing students by sentiment and topic help understanding the situation and gathering information to detect the difficulties experienced by students.
- Supports: help a group of students who express special needs to overcome their difficulties.
- Reference: orient students who have difficulty in a topic to specialized resources in relation to that topic
- Monitoring: the problems faced by students must be followed by their teachers

5. EXPERIMENTS AND RESULTS

5.1. Data Sets

We need two categories of corpus for analysis, the first to analyze and evaluate the sentiments of students and the second to extract the corpus.

Facebook allows interaction with the site via several APIs; the most interesting API is Graph, which helps us to access to the properties of an object by invoking its URLGraph (JSON file format). All objects are connected and can be accessed by providing a valid access token; we use the PHP SDK to access to this information: Post, Comment, Student, and Time.

Figure 3, shows how it's supposed to be managing the page, and Figure 4 the Facebook API result which will be store in the database for the analysis.

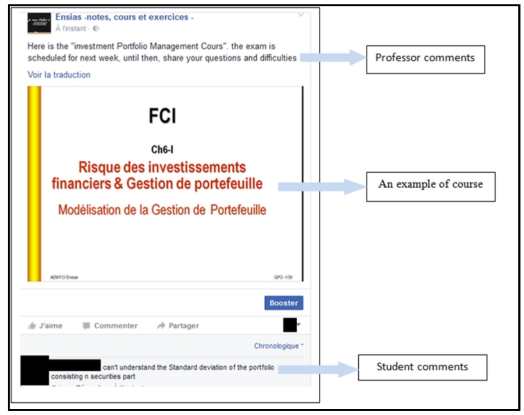

Figure 3: Example of Facebook post

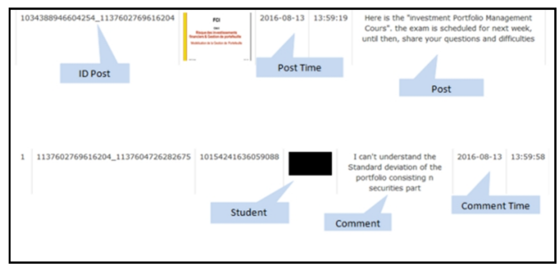

Figure4: Facebook Post in database

To evaluate the approach we chose three sets of open group on Facebook related to learning, we make manual cleaning of general information as well as advertising or comments on images,…. some basic information of the corpus Table 1:

Table 1: Overview on the corpus

Corpus	#Comments	#Learning	#Test
Learning English *@LearnEnglish. BritishCouncil*	7200	5760	1440
Medicine *@The.AIHMedicine*	2400	1920	480

5.2. Extracting sentiments

After the training step on the corpus, we base our work on the indicators (6), (7), (8) and (9) and Table 2 to evaluate our system.

Table 2: how much predictions draw from and reflect reality

	Event = positive	Event = negative
Prediction= positive	TruePositive	FalsePositive
Prediction =negative	FalseNegative	TrueNegative

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$$\text{Precision} = \frac{\text{T}}{\text{T} \quad +\text{f}} \qquad (6)$$

$$\text{Recall} = \frac{\text{T}}{\text{T} \quad +\text{f}} \qquad (7)$$

$$\text{Accuracy} = \frac{\text{T} \quad +\text{T}}{\text{T} \quad +\text{f} \quad +\text{T} \quad +\text{f}} \qquad (8)$$

$$\text{F1 score} = \frac{2.\text{p} \quad .\text{r}}{\text{p} \quad +\text{r}} \qquad (9)$$

We summarizes the results in the Table 3, where we can see that the algorithm allows to extract a significant number of subjective discussion with great accuracy

Table 3: Indicators

Corpus	Precision	Recall	Accuracy	F1 score
Learning English *@LearnEnglish.BritishCouncil*	92,81%	60,3%	63,18%	73,1%
Medicine *@The.AIMedicine*	83,58%	100%	83,58%	91%

We highlight some of the finding in Table 4

Table 4: Sentiment Analysis Examples

Examples	Negative	Positive
Though, some answers are ambiguous.	x	
easy, but they have called things both synonyms and antonyms that aren't	x	
big thank you to all the teachers helping us with our questions and comments!		x
Great! I appreciate the lesson a lot!		x
I love this new course towards advance ;)		x
It's such a nice episode .		x
Very helpful !		x

5.3. Topic Model

After ranking student feedback in both positive and negative categories that correspond in our case to "weak point" and "strong point" we apply LDA algorithm on each comment class.

The model parameters (Figure 1) are not initially known, we must try to learn them from observable data, i.e. the words in the comments; we use the Gibbs Sampling inference method to determine the hidden variablesz_n and θ.

The variables α and β are estimated at 0.5 and 0.1 respectively.

We present in table 5 some topic detected with a few words that characterizes them and the sentiment shared by the students.

Table 5: Topics & Sentiment analysis Examples

Sentiment=Positive	
Topic 1	**Topic 2**
Health, medicine, young, prevent, digestion, efficacy, preventative	*Verbs, mean, synonyms, person, explanation, simply*
Sentiment=Negative	
Topic 3	**Topic 4**
Difficult, informal, confuse, present, phrase	*Health, child's, sleep, kidneys, indicators, addictive, deficiencies*

This analysis concluded that teachers can get a clear idea about the difficulties that students encounter in their learning experience and, therefore, about the issues that need improvement as is the case with Topic 3 where we can distinguish a group of students with difficultie in verb conjugation, the teacher in this situation has a choice to group these students into learning groups or directing them to appropriate and specialized resources in relation to that topic.

5.4. Discussions and Limitations

Teachers who use Facebook or other social networks in their learning process, admit that Facebook has developed their teacher roles to educational engineers who create and run an environment where learning is valorized, where the unity of the group must be maintained, where students work for the same objective, and an environment that requires attention of the groups to focus on the crucial points, and where students are free to ask questions, to discuss and consider critical concepts; this is a difficult task for teachers because it requires developing and adapting specific and complicated learning methodologies, we

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mention also that all Facebook data are saved and Facebook does not put limits in the relationship that can exist between two people, for example, in an educational context, we cannot imagine a teachers who is “friend” with a student or a student who “like” or “do not like” a course or a post of a teacher, and this makes students careful of their use and their languages on Facebook; on the other hand it requires the teacher to be a good communicator who is able to help students and influence them to develop interesting discussion than can strengthen their learning.

Communication is very important in learning, but for an isolated student in the classroom nothing guarantee that he will be more active on Facebook, thus, in order to identify these type of students, teachers can distinguish them by using the presented tools :absent in all topic detected. On the other hand, for a student that is present and active in several topic and shares several opinions and feedback, it does not mean that he has problems understanding the course; and here we notice the importance of the face-to face communication that will help the teacher discuss and analyze the outcome of the previous discussion on Facebook.

We may also find a student who comments a post in which he described a problem or a difficulty, and maybe there are more students who have the same problem but do not comment on the post and instead, they wait for the teacher’s reply; and this will make the teacher think that only one student has this difficulty; this type of problem will depend on how the teacher organizes the group, here a Facebook use contract must be established between the student and teacher.

The other limitation of the present work is that analysis was confined to students’ discussions conducted in the English language. This means that other languages such as French and Arabic should be taken into consideration in our future works.

6. CONCLUSION

In this article we explored one of the uses of Facebook in education, we used the sentiment analysis algorithms to detect students who have difficulties in specific modules, and then we used Topic Model technique to classify these students according to the discussed topic. The results can be used as a prevention tool for teachers, to understand the difficulties experienced by students, and orient them to specialized resources related to the detected Topics. The article has several perspectives, for example, in relation to the algorithms, testing their behavior toward a corpus written in a foreign language other than English. Another future orientation will be interesting to work on which is: predicting the difficulties that students can encounter.

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