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Towards An Intelligent Arabic-Speaking Tool for Dyslexia Screening Using Naturallanguage Processing

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Abstract

Reading is a fundamental skill for children and is crucial to their educational development. However, this development is not always smooth and simple. Some children exhibit specific difficulties known as reading disorders. These disorders vary from case to case; they can range from severe conditions such as dyslexia to less severe forms of learning difficulties, affecting a child's ability to read fluently and comprehend text. In this paper, we proposed anArabic-speaking Tool for Dyslexia Screening based on Natural Language Processing (NLP) and Artificial Intelligence (AI) for problems detecting of Dyslexia in children and for accurate test to measure the student's reading performance.

Keywords: *Arabic-speaking, Dyslexia Screening, IntelligentTool,Natural Language Processing.*

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1.Introduction

Reading is an essential skill for the student and is very important in his educational development, but this development is not always a simple smooth. We notice in some children the emergence of specific difficulties known as reading disorders. These disorders differ from one case to another; It may range from severe cases such as dyslexia to other forms less dangerous than learning difficulties, which affects the child's ability to read smoothly and understand the text. Here it should be noted that reading is a complex activity that includes the treatment of the graphic symbols of the language, the formation of the sounds represented by these symbols or their structures, whether mentally or loudly, and linking these sounds with specific meanings. Reading occupies several cognitive and linguistic capabilities, including: visual perception, identification of words, language understanding, and working memory. The harmonious development of these capabilities enables the child, usually at the age of five to six, to be ready to start learning to write, and it may take on the average of the average child from two to three years of regular regular learning in order to be able to read simple texts smoothly such as short children's stories and if there are some rare reading errors related to new words, this is normal, the reading performance is still in the stage By learning Arabic reading, we can find a variation in the different language.Snowing, (M. J., Hulme, C., & Nation, K. 2022)

The difficulties facing the child in reading do not necessarily mean a reading disorder. Reading difficulties may be temporary and often exceed the practice and appropriate education. These difficulties may be linked to a lack of reading, or in inappropriate teaching methods, or even to a decrease in motivation for learning.

As for the reading disorder, it is characterized by the presence of continuous difficulties in learning and practicing reading is not due to a lack of education or to the presence of mental insufficiency. The specific disorders, such as dyslexia, show a noticeable difficulty in identifying words, and difficulty decoding texts and understanding what is read, despite the presence of natural intelligence and appropriate educational opportunities. These disorders often require special and appropriate interventions to help the child develop his reading skills.

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So, dyslexia is a specific learning disorder, which is difficulties in identifying words, low reading speed, and frequent errors in dictation. People with dyslexia may face problems deciphering words and linking them properly with their voices, thus affecting the understanding of texts.(Shaywitz, S. E., &Shaywitz, J. 2020)

And because of the seriousness and spread of these disorders, early identification of the signs of reading disorders and the application of appropriate intervention strategies is a basic step to ensure the development of the child's reading skills and enhance his confidence in himself, which contributes to achieving comprehensive educational integration that develops his cognitive and linguistic skills effectively.(Handler, S. M., &Fierson, W. M, 2011).

This goal can only be accessed by following precise diagnostic steps that begin isolating all mental, psychological, social and educational factors and to the application of accurate tests to measure the reading performance of the student.In this paper, we proposed an Arabic Dyslexia Tool basedon NaturalLanguage Processing (NLP) and Artificial Intelligence (AI) for problems detecting of Dyslexia in children and for accurate test to measure the student's reading performance.

The paper is structured as: Section 2 Explain the problem,Section 3Explain the concepts of Arabic Dyslexia.Section4 Artificial Intelligence (AI). Section 5 presents the Arabic Arabizi system. In Section 6, we detail the implementation. Section 7 concludes the papers.

2.Problematic:

An accurate diagnosis of reading disorders is a great relief for many parents and their children. It provides convincing reasons for the difficulties they face and begins the development of an appropriate treatment plan. Parents, and even some specialists, often attribute reading disorders in some children to limited intelligence and lack of motivation, which can lead to disastrous consequences for self-esteem. The field of learning disabilities is fraught with obstacles and is marred by considerable confusion among specialists, at least in the Arab world. Therefore, it is important to be cautious and follow precise scientific steps in diagnosis, which is the first step towards providing appropriate care for affected children. The earlier a diagnosis is made, the more effectively dyslexia can be addressed. It is easy to get lost among the myriad healthcare professionals to consult, who perform tests that seem vague and incomprehensible to the general public (such as speech pathologists, clinical psychologists, specialist physicians, etc.). The first step in diagnosing a reading disorder is usually a school-based assessment, often involving teachers' observations of a child's persistent reading and/or writing difficulties. This is a sign that warrants attention and early intervention, although it is not yet considered a formal diagnosis. (Écalle, J., & Magnan, A. 2010)

The second step is the intervention of the Speech Therapist.

Once these early signs are detected, it becomes necessary to consult a Speech Therapist who will conduct a series of specific tests to assess the child's reading and writing skills, as well as memory, attention, and auditory perception. To rule out any mental or psychological disorders, social deprivation, or educational maladjustment, the specialist conducts additional tests and interviews with the child, parents, or even the child's educational supervisors to isolate all of these factors. This is where the next step is to apply multiple tests and measures specifically designed to suit the child's age and abilities. These tests include the reading performance test, also known as reading aloud tests, letter recognition tests, and oral comprehension tests. After completing these tests, Speech Therapist will be able to accurately confirm or rule out the presence of dyslexia.(Dumont, A, 2003).

All of the above briefly illustrates the difficulty and complexity of diagnosing a reading disorder and specific learning disorders in general. What makes this even more complex is the final step before beginning a treatment plan: identifying the specific type of reading disorder. Given the above, this paper attempts to make this process less complex and reduce the cost of time and effort by proposing a Arabic Dyslexia Tool for specialists whose function is to measure a student's reading performance. This self-correcting application provides us with the degree of reading difficulty a student suffers from, which can be used to

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infer whether a reading disorder exists. It can also reveal the time spent reading and the reading errors a student makes. It can also identify the type of reading disability a student suffers from.

3. Arabic-speaking dyslexic:

A deficiency in converting written linear symbols into audible spoken symbols with imbalances in understanding what is readable.

Symptoms of dyslexia: We can divide the symptoms of dyslexia into two types, the first is symptoms of reading performance, while the second is accompanying symptoms (physical, behavioral, behavioral). (Layes, S., Guendouz, M., Lalonde, R., & Rebai, M; 2020)

These are the mistakes in which Asir reading makes:

A- Reading performance:

It is difficult to read many imbalances, whether on the tombly side of the readable text or the grammatical and morphological side, or the rhythm and smoothness of the reading or the semantic side. We will try to mention the most important of these imbalances.

* The grammatical side: Arab errors that appear in the failure to adjust the shape of the late words, transformational errors (masculine, feminine, plural, single ...). I mean, he/she makes a mistake in forming words, as well as: a word for exemaple (مكتبة يقراها مكتب، او مكاتب يقراها مكتب)

* Syllabic aspect: It appears in a single word through: deletion, inversion, substitution, augmentation, etc.

Example:

Deletion :(متشفى ـــــــــــــــ مستشفى)

the heart :(سمش ـــــــــــــــــــــــ شمس)

The compensation :(حولة ـــــــــــــــــــــــ خولة)

The increase :(كتاب ـــــــــــــــــــــــ كتب)

We also notice a confusion between letters that sound similar (ذ,ث) ;(ط,ت),(س,ز), It means similar in pronunciation. Also similar visually (ر,ز),(س,ش),(ح,خ) ,It means similar in writing.

* Reading rhythm: Sometimes it's too fast, with punctuation not being respected, words being omitted, transitions from one line to the next, or a return to a skipped line. Or the rhythm is too slow, with words being cut off.

He/shereads:الجو مشمس اليوم

الـ - جـ- و مـ- شـ - مـ - س الـ- يـ- و- م

* Semantic aspect: A shift in the meanings of words is observed, as well as a clear deficiency in comprehension, evident in (the inability to answer and incorrectly answer comprehension questions after silent or aloud reading. Furthermore, if we ask a dyslexic student to retell a story they have read or summarize it, they demonstrate a clear weakness in this process.)

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We also note that dyslexia is often accompanied by dysgraphia, which exhibits the same errors found in reading.

4. Artificial Intelligence (AI) and Natural Language Processing (NLP)

(Kok, 2009) AI trying to imitate intelligent behavior with computer programs. In (Sil et al 2019) AI is based on the designing of smart computer systems that collects information, solves and makes decision and also act in an intelligent manner that is relatable to the intelligence of human mind. AI is the software programming for but imitation of human intelligence, i.e. observing, studying and analyzing how human beings reason and solve problems then translate these actions and activities into programming in the machine (Bensattalah et al, 2024).

To create an AI There are several approaches, such as Expert systems, Machine Learning approaches and others.

An expert system approach requires developers to create a rules, knowledge and Inference to imitate the work of experts. An expert system programming with mathematical logic (Propositional logic , First-order logic) using the language programming such as LISP or PROLOG.

Machine Learning approach based on the construction of database, datasets or Big data then application of an algorithm of Machine Learning for the machine to learn. Several datasets in the web, we quote the most used the platform Kaggle((kaggle ,2023),which provides datasets in several domains. In Machine Learning approach there are the methods or algorithms such as: Supervised learning : Decision Tree, Random forests, Naive bayes,SVM, Neural networks (MLP, RNN, etc.); Convolutional neural networks (CNN), deep neural networks (VGG-16, ResNet, LSTM, GRU, ...). Unsupervised learning : (K-means, GMM Gaussian Mixture Models, (PCA) Principal component analysis…)

In addition many studies addressed them to enhance the performance of Natural Language Processing (NLP) tasks with using Artificial Intelligence (AI) . In this context, Arabic Natural Language Processing (ANLP) has interest in the web application and social media platforms, making it one of the most important research topics, especially in North Africa and Arab World. Classical Arabic (CA), Modern Standard Arabic (MSA), and Dialectal Arabic (DA) are the three primary forms of Arabic (Chelghoum,2017; Guellil et al 2021, Guellil, I.,2017). Arabic Natural Language Processing (ANLP) using for machine translation, information retrieval, synonym search, automatic correction, Sentence parsing Letter diacritics, text a grammatical category, such as nouns, verbs, adjectives, and adverbs. etc.

Many application field of AI and NLP, Google (Devlin, et all,2018) in 2018 develop and used BERT model for natural language-processing tasks. (Antoun, et al. 2020) developed an Arabic model that they called Arabert. Chat GPT (openai ,2023) ;plagiarsim detection (Hunt et al 2019) Chitra, A., & Rajkumar, A. (2016). ;Speech recognition (Vashisht et al,2021). Speech to text or text to speech (Trivedi et al 2021 ;Hebbi et al 2022) .document Classification (,Jiang, et al 2022;Muaad et al,2022),) Extraction of key phrases from Arabic text (Muhmmad et al 2018). Language dialect such as Algerian dialect (Hamadouche,et al,2023 ; Guellil et al 2021, Guellil, I.,2017). Analyse sentiment arabic (Farha et al 2019), Analyse sentiment of arabic Hotels' reviews(Mohammad Al-Smadi et all 2017). (Lalwani,et all 2018, Nursetyo, A., &Subhiyakto, E. R. (2018), Youness,2024) Proposed a chatbot based an artificially intelligent and NLP which can converse with humans. Negation and speculation detection in Arabic Review (Mahany,et all 2022, Mahany,et all 2023). In addition, several Arabic lemmatizers and POS taggers, have been proposed MADAMIRA(Pasha et al,2014);Farasa(Mubarak,2018);SinaTools (Hammouda et al,2024),Alma(Jarrar et al,2024);Khoja(Khoja et al,1999);Tashaphyne base stemmer (Zerrouki,2018), enhanced Arabic light stemming algorithm(Al-Khatib), Assem's Arabic Light Stemmer(Chelli, Assem (2018).

5.Proposed architecture and Implementation:

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In this section, the proposed Arabic Dyslexia Tool algorithms is discussed. We used Python for implementation the tool Arabic Dyslexia to perform four main functions with using the Artificial Intelligence for transform speech into text.

Speech to text (‘audio‘) : This function transform speech into text

Remove Repeat (‘text ‘) : This function removes letters repeated several timesandcount the number of repeated letters.

Tagger Arabic (‘text’) : This function used for Named Entities Recognition

Translation (‘text’) : This function convert from a source text into the corresponding target text

Algorithme of Remove Repeat(‘text ‘)

```
 repeatharfe  = ['ظظ'.....'تت','بب','اا']
 harfe = ['ظ'.....'','ت','ب','ا']
s=split(text)
for i in range(length(repeatharfe):
        remove_repeat = re.sub(repeatharfe [i],h=harfe [i],s)
remove_repeat
```

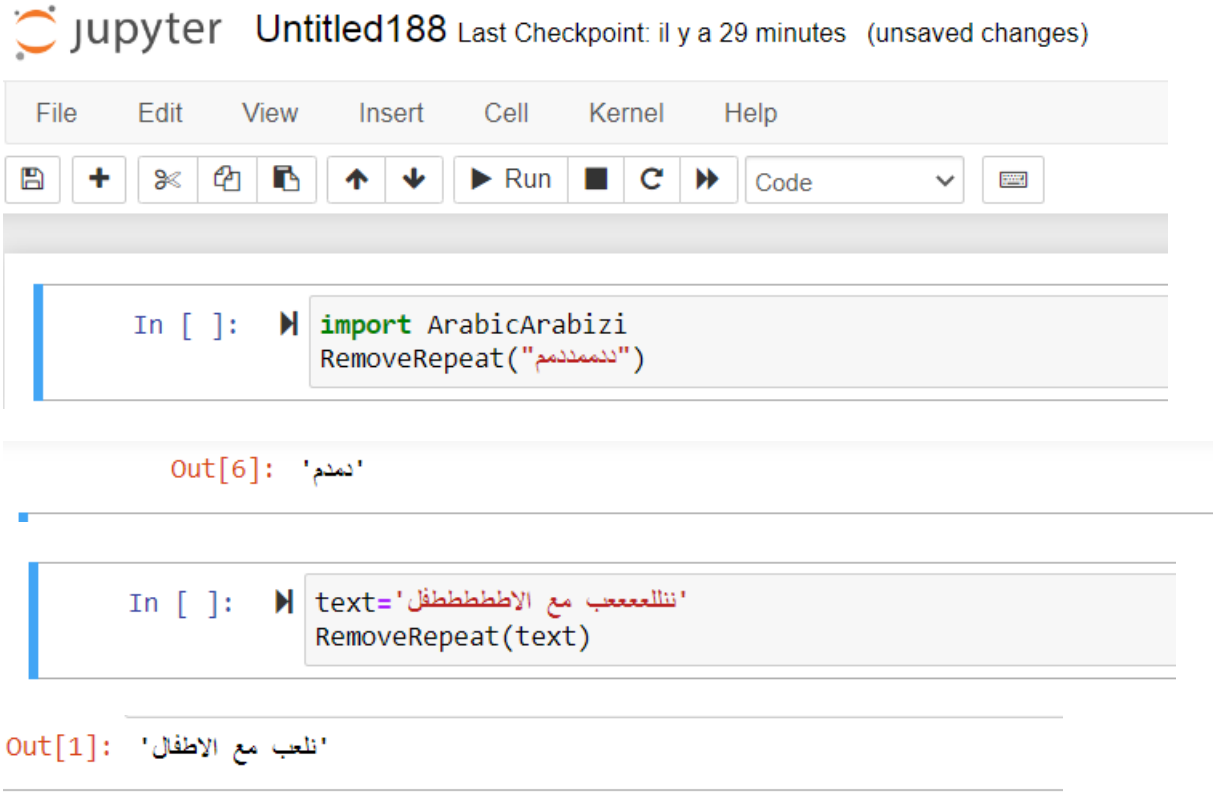

Figure 1: removes letters repeated several timesin Python

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Figure 2: Recognizing difficulty Reading

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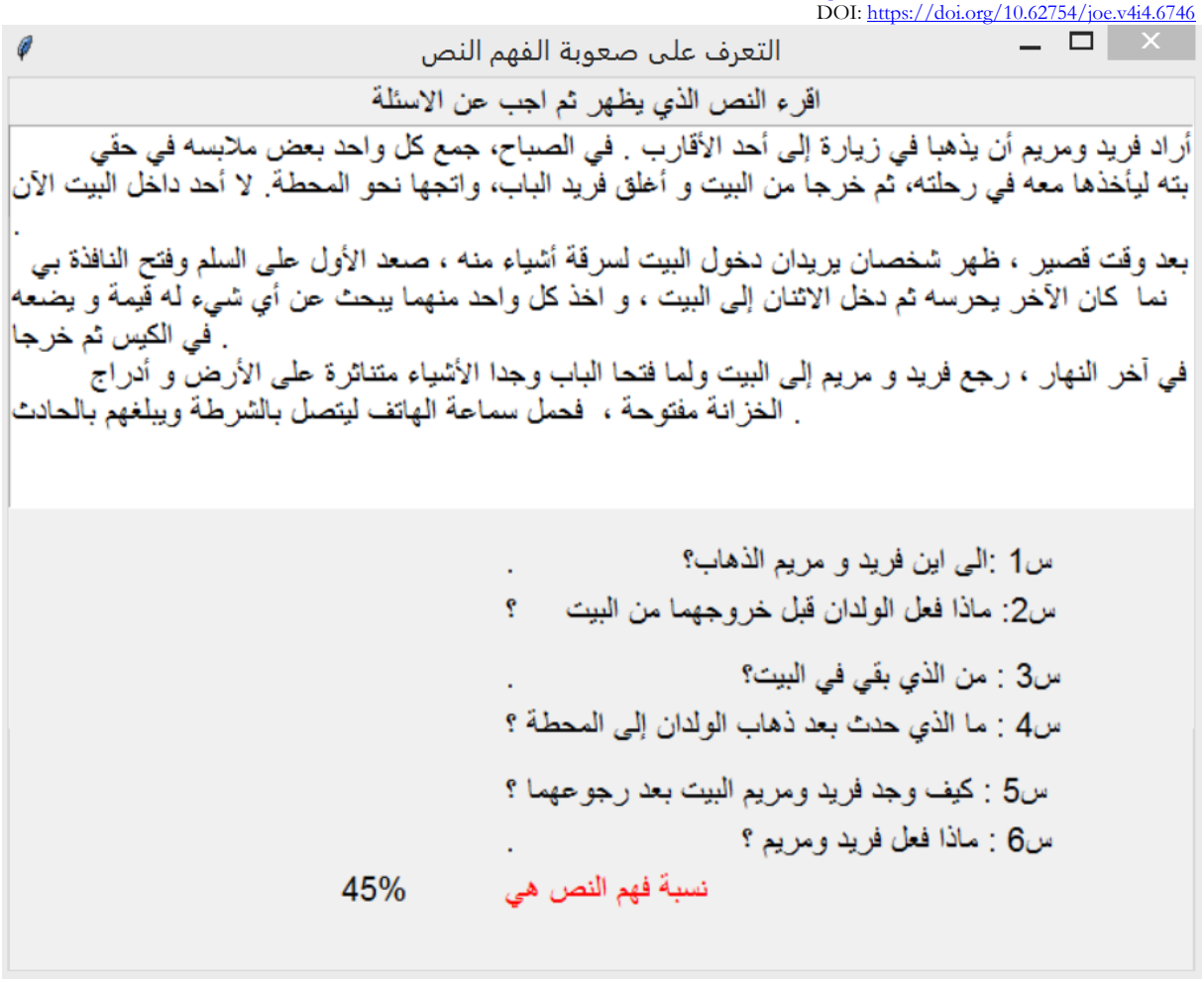

Figure 3:Measurementand identifying text comprehension difficulties

6.Conclusions:

In this paper, we proposed a In this paper, we proposed an Arabic-speaking Tool for Dyslexia Screeningbased on NaturalLanguage Processing (NLP) and Artificial Intelligence (AI) for problems detecting of Dyslexia in children and for accurate test to measure the student's reading performance.

the tool in its initial form proved an ability to accurately diagnose dyslexia, especially in terms of reading time, detecting and categorizing reading mistakes, and to an accurate measurement of reading comprehension, but it needs more work to classify the type of dyslexia, in addition to developing it in terms of form to facilitate its use by non-specialists such as teachers and parents.

In the future, we aim to improve and enrich the algorithms of Dyslexic Arab students then make it open source to test and improve by researchers and professionals

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