Linguistic and Philosophical Investigations
ISSN: 1841-2394, e-ISSN: 2471-0881
Vol 23 (1), 2024
pp. 756 - 779

A Computational Tool for Arabic Trilateral Abstract Geminate Verbs Morphology

[1] Wafaa Kamel Fayed, [2] *Ahmed Allaithy

[1]Professor of Arabic, Faculty of Arts, Cairo University. Member of Cairo Arabic Language Academy.

Email Address: wafkamel@yahoo.com

[2] American University of Sharjah, Department of Arabic and Translation Studies, Sharjah, United Arab Emirates ,

Email Address aliahmed@aus.edu

ORCID: 0000-0002-1131-8693

Abstract: This paper addresses the complex challenge faced by both learners and users of the Arabic language: the precise identification of morphological patterns and categories associated with the imperfect verb, particularly focusing on the trilateral abstract geminate verb. The ultimate objective of this project is to create a software application that streamlines this identification and determination process, thereby enhancing the learning journey and elevating proficiency in the Arabic language. To realize this objective, an exhaustive investigation was conducted into the relevant verbs, drawing from diverse Arabic dictionaries including Al-Fayrūzabādī's al-Qāmūs al-muHīT Dictionary, as well as entries from Ibn ManĎūr's lisān al-çarab and az-Zabidi's tāj al-çarūs min jawāhir al-qāmūs. This process yielded a comprehensive database of 562 entries, meticulously tabulated to include detailed morphological conjugations. Notably, considerations were extended to encompass the points and range of articulation, as these factors exert influence on the verb patterns. Subsequently, the developed software application underwent rigorous testing involving diverse groups of language users and learners, totaling 119 participants. Each participant was presented with a distinct test comprising a list of 10 verbs, tasked with determining the appropriate imperfect form. The accuracy of participants' responses ranged from 40.67% to 50.80%, underscoring the significance and necessity of the software's development. Moreover, the study unveiled four distinct categories to which the verbs under investigation belong, presenting a pivotal revelation in the realm of Arabic verb analysis.

Key Words: morphological patterns; trilateral verbs; abstract geminate verbs; software program; Computational linguistic study; Arabic Language

Received: 12 May 2024 Revised:06 June 2024 Accepted: 22 June 2024

1. Introduction

Numerous studies focused on error analysis within the realm of Arabic linguistics clearly highlight a daunting challenge: accurately determining the morphological patterns or categories to which an imperfect verb corresponds. This complexity poses difficulties for both native and non-native Arabic speakers, often leading to errors in usage.

Drawing from an extensive background of university-level teaching, I can affirm the validity of this assertion. It is within this context that the imperative to simplify this process emerges, with the overarching goal of liberating Arabic speech and writing from this pervasive error.

For ease of reference, the pertinent Arabic terms have been transliterated, adopting the same conventions as presented in "Arabic Computational Morphology," a publication by Springer. To enhance this system, the symbol (ᶜ) has been introduced to denote the Arabic *hamzah* sound. Additionally, the elongated Arabic vowel sounds /ā/, /ī/, and /ū/ have been incorporated (Refer to Appendix II).

Research Objectives

The overarching goal of this long-standing study, initiated fourteen years ago, is to develop a software program that addresses the aforementioned challenge. This program's purpose is to streamline the identification and determination process for users of the Arabic language, thereby enhancing the learning journey and fostering improved competencies and mastery of Arabic. This study also seeks to address the following pivotal questions:

1. To what extent do the existing Arabic language skills of both native and non-native speakers enable them to accurately ascertain the correct morphological pattern(s) of trilateral abstract verbs in Arabic, particularly in their present tense conjugations?

2. Can a computer program, designed to deduce the accurate morphological pattern(s) of trilateral abstract verbs in Arabic, successfully achieve this task even in the absence of vowel sounds? Moreover, can the program effectively discern between different potential patterns, considering that certain verbs can be conjugated following multiple patterns, each bearing distinct meaning(s)?

2. Significant Considerations and Theoretical Overview

Prior to addressing the strategies aimed at addressing the research objectives and questions, it is essential to underscore several linguistic considerations. These considerations wield a profound impact on the entirety of the project, particularly in terms of design and application.

• The majority of Arabic verbs are rooted in trilateral structures, comprising three fundamental consonants that encapsulate the verb's core meaning. Some verbs remain mujarrad (or abstract), solely consisting of their three radicals. For instance:

Trilateral Verb	نَصَرَ	ضَرَبَ	سمَحَ	كَرُمَ	عَلِمَ	حَسِبَ
Transliteration	**n**a-**S**a-**r**a	**D**a-**r**a-**b**a	**s**a-**m**a-**H**a	**k**a-**r**u-**m**a	**ç**a-**l**i-**m**a	**H**a-**s**i-**b**a

Table 1. (The vowel letters are for ease of pronunciation only).

• Moreover, a trilateral verb can also take the form of *mazīd*, which involves additional letters that enhance the core meaning of the verb. Noteworthy instances of such *mazīd* verbs include istaxraja, iktasaba, taDāraba, cakrama, and taçallama. In these examples, the bold letters signify the trilateral roots. In istaxraja, for instance, the letters /ist/ are appended to the root represented by the three consonants /xrj/. These additions convey the notion of soliciting or summoning an action.[1] The root /xrj/ signifies the act of emergence, while the inclusion of /ist/ transforms the verb to signify "to request or summon something or someone to emerge," essentially meaning "to extract."

• In /iktasaba/, the prefix /i/ and the infix /t/ are affixed to the trilateral root /ksb/, which inherently implies "to gain or earn." These supplementary letters imbue the verb with the essence of expending effort in pursuit of earning or acquiring gains.[2]

[1] C.f., Sībawayh, 1982, v.2, pp. 239-240; Al-Istrābāði, 1982, v.1, p.110; Ibn Yaçīš (n.d.), v.7, p.161; Al-XaTīb (2003), v.1, p.357.

[2] C.f., Sībawayh, 1982, v.2, pp. 241; Al-Istrābāði, 1982, v.1, p.96; Ibn Yaçīš (n.d.), v.7, p.160; Al-XaTīb (2003), v.1, p.336.

• The introduction of the letters /t/ and /ā/ to the trilateral root /Daraba/ results in the formation of the verb /taDāraba/, infusing it with the concept of multiple individuals participating in the corresponding action.[3] This is an extension of the root /Daraba/, which denotes "to strike."

• In the case of /ᶜakrama/, the incorporation of the supplementary hamzah /ᶜ/ transforms the trilateral root verb /karuma/ into a transitive form.[4] This signifies that the core meaning, revolving around generosity or hospitality, extends from one person to another.

• Lastly, appending the letters /t/ and /l/ to the trilateral root /çlm/, rooted in the domain of knowledge, results in the formation of the verb /taçallama/. This conveys the idea of ease in the outcome of an action.[5] Hence, while /çlm/ denotes knowing, /taçallama/ signifies "to learn," denoting the acquisition of knowledge or skills through study or instruction.

• The Trilateral Abstract Geminate Verb: This specific verb type comprises two letters in its written form, with the second letter being geminate, i.e., doubled in pronunciation without altering its adjacent speech sound.

Examples are:

Trilateral geminate Verb	شَبَّ (to grow up)	ردَّ (to return)	مَدَّ (to extend)	دَبَّ (to tread)	غَـصّ (to choke)
Trilateral geminate Verb *broken*	(شَ بْ بَ)	(رَدْدَ)	(مَ دْ دَ)	(دَ بْ بَ)	(غْ صْ صَ)
Transliteration	**ša**b**b**a	**ra**d**d**a	**ma**d**d**a	**da**b**b**a	**ɣa**S**S**a

Table 2

The past tense verb /madda/ transforms into /yamuddu/ in the present tense. This aligns with the pattern observed in the mujarrad (abstract) verb /naSara/, wherein the present tense form is /yanSuru/. However, a contrast emerges with the past tense verb /dabba/, which becomes /yadibbu/ in the present tense, and the past tense verb /ɣaSSa/, which transforms into /yaɣaSSu/. Evidently, while these three geminate verbs share a common morphological structure in the past tense, a perplexing alteration occurs during the conjugation process for the present tense, resulting in three distinct vowel sounds—/u/, /i/, and /a/ sequentially. This constitutes the crux of the linguistic enigma. Thus, the fundamental question surfaces: what precisely triggers this transformation?

In the endeavor to address this pivotal query, it becomes imperative to elucidate certain foundational rules within Arabic morphology, as outlined below:

• The Arabic Trilateral Abstract Verb encompasses six distinct morphological patterns:

	Past form pattern	Present form pattern	Example (transliterated)	Example (Arabic)
1	فَـعَـلَ /façala/	يَـفْـعُـلُ /yafçulu/	/naSara - yanSuru/	نَصَرَ ، يَنْصُر
2	فَـعَـلَ /façala/	يَـفْـعِـلُ /yafçilu/	/Daraba - yaDribu/	ضَرَبَ، يَضْرِب
3	فَـعَـلَ /façala/	يَـفْـعَـلُ /yafçalu/	/fataHa - yaftaHu/	فَـتَحَ ، يَـفْـتَـح
4	فَـعُـلَ /façula/	يَـفْـعُـلُ /yafçulu/	karuma – yakrumu/	كَـرُمَ ، يَـكْـرُم

[3] C.f., Sībawayh, 1982, v.2, pp. 239; Al-xaTīb (2003), v.1, p.351.
[4] Al-Istrābāði, 1982, v.1, p.86; Ibn Yaçīš (n.d.), v.7, p.159
[5] C.f., Sībawayh, 1982, v.2, pp. 240; Al-Istrābāði, 1982, v.1, p.104; Al-xaTīb (2003), v.1, p.3422.

5	فَـعِـلَ /façila/	يَـفْـعَـلُ /yafçalu/	/çalima - yaçlamu/ and /fariHa – yafraHu/	عَلِمَ ، يَـعْلَـم/ فَـرِحَ ، يَـفْـرَح
6	فَـعِـلَ /façila/	يَـفْـعِـلُ /yafçilu/	/Hasiba - yaHsibu/	حَـسِـبَ ، يَـحْـسِـب

Table 3

• In some cases, two geminate Arabic verbs may share one of their two letters, as seen with عَبَّ /çabba/ and عَفَّ /çaffa/, where the first letter/sound /ç/ is common while the second differs, represented as /b/ and /f/ respectively. Other instances include أَمَّ /ᶜamma/ and أَنَّ /ᶜanna/, as well as ظَنَّ /Ďanna/ and ظَلَّ /Ďalla/. Intriguingly, despite the shared initial consonant, the present tense form of /çaffa/ is /yaçiffu/ (عَفَّ - يَعِفُّ), following the pattern of the verb /Daraba - yaDribu/ (ضَرَبَ - يَضْرِبُ), as depicted in morphological pattern 2 in Table 3 above. This contrasts with the verb /çabba/ (عَبَّ), whose present form is /yaçubbu/ (يَعُبُّ), adhering to the pattern of the verb /naSara - yanSuru/ (نَصَرَ-يَنْصُرُ), as shown in morphological pattern 1 in Table 3 above. Thus, despite the shared range of articulation between the bilabial /b/ and the labiodental /f/, the divergence in the second letter/sound yields distinct morphological patterns upon conjugation.

• Similarly, the verb /camma/ (أَمَّ) takes the present form /yacummu/ (يَؤُمُّ), following the pattern of /naSara - yanSuru/ (نَصَرَ-يَنْصُرُ), as reflected in morphological pattern 1 in Table 3 above. Conversely, the verb /canna/ yields the present form /yacinnu/ (يَئِنُّ), adhering to the pattern of /Daraba - yaDribu/ (- ضَرَبَ يَضْرِبُ), as represented in morphological pattern 2 in Table 3 above. Notably, despite the nasal quality of both /m/ and /n/ sounds, their distinct points of articulation—bilabial for /m/ and alveolar for /n/—induce dissimilar patterns.

• Similarly, the two geminate verbs ظَنَّ /Ďanna/ and ظَلَّ /Ďalla/, which share the same initial letter, align with distinct verb pattern categories in the present tense as illustrated below:

- Ďanna – yaĎunnu, following the /naSara - yanSuru/ pattern (1, Table 3);
- Ďalla – yaĎallu, following the /fataHa - yaftaHu/ pattern (3, Table 3). This divergence persists despite the similar alveolar articulation of /n/ and /l/.

Based on the foregoing exposition, it is evident that a meticulous determination of the morphological pattern of trilateral abstract geminate verbs is essential. This precision serves to enhance their application, mitigate confusion, and avert errors. Consequently, a software program tailored to ascertain the appropriate morphological pattern emerges as a pressing necessity.

To realize this objective, the program leverages a comprehensive corpus, incorporating encyclopedic Arabic dictionaries. Notably, a cornerstone resource for tracing and assembling Arabic trilateral verbs is al-Qāmūs al-muHīT, which encompasses around 60,000 entries. However, this formidable and time-intensive task has often contributed to the neglect of this critical research domain by many linguists.

Given that the corpus includes geminate verbs from classical encyclopedic dictionaries, meticulous attention is directed towards the attributes of each sound as pronounced in the past. Consequently, the attributes adopted in this research paper align with the descriptions offered by esteemed Arabic grammarians Al-Xalīl and Sībāwayh. For instance, the modern characterization of /T/ as a whisper sound contrasts with its historical description as majhūr. Appendix III provides a comparison between classical and contemporary descriptions.

Situating the Current Research within the Broader Context of Computational Linguistics and Morphological Analysis

Computational linguistics is an interdisciplinary field that combines linguistics and computer science to analyze and synthesize language and speech using computational methods. One of the core areas within this field is morphological analysis, which involves studying the structure and formation of words. Morphological analysis is crucial for natural language processing (NLP) applications, such as machine translation, speech recognition, and text-to-speech systems.

Arabic Morphology and its Challenges

Arabic is a morphologically rich language, characterized by its root-and-pattern morphology, where words are formed by inserting roots into specific morphological templates. This complexity poses significant challenges for computational analysis. Trilateral geminate verbs, a specific category of verbs in Arabic, are particularly intricate due to their unique morphological patterns and variations. Accurate analysis and processing of these verbs are essential for improving NLP applications for Arabic.

Previous Work in Arabic Morphological Analysis

The field of Arabic morphological analysis has seen significant advancements, with various tools and approaches developed over the years. Some notable efforts include:

1. MAGEAD: This system provides a morphological analyzer and generator for Arabic verbs, focusing on modern standard Arabic and several dialects (Habash & Rambow, 2006).

2. ALMORGEANA: This analyzer and generator handle Arabic morphology, including complex derivational forms (Habash, 2010).

3. MADAMIRA: A tool for morphological analysis and disambiguation, integrating machine learning techniques for better accuracy (Pasha et al., 2014).

4. Farasa: A fast and accurate segmenter and POS tagger for Arabic, offering morphological analysis capabilities (Darwish, Mubarak, & Abdelali, 2014).

While these tools provide robust solutions for general Arabic morphological analysis, they do not specifically address the unique challenges posed by trilateral geminate verbs.

Innovations in the Current Research

The research presented in this paper introduces a novel computational tool explicitly designed for the accurate analysis of Arabic trilateral geminate verbs. The uniqueness of this tool lies in its ability to handle the specific morphological patterns of these verbs, which have not been comprehensively addressed by existing tools.

Corpus-Based Approach

As will be outlined below, the software utilizes a corpus-based approach, compiling a comprehensive database of verbs from authoritative Arabic dictionaries such as Al-Qāmūs al-Muḥīṭ, Lisān al-ʿArab, and Tāǧ al-ʿArūs. This extensive corpus forms the foundation for accurate morphological analysis and pattern recognition.

Empirical Validation

The effectiveness of the software is demonstrated through empirical validation involving 119 participants, both native and non-native Arabic speakers. This rigorous testing provides evidence of the software's practical utility and accuracy in predicting verb forms.

Contribution to the Field

This research makes significant contributions to the field of computational linguistics and morphological analysis by:

1. *Addressing a Gap*: Filling a critical gap in Arabic morphological analysis by focusing on trilateral geminate verbs.

2. *Innovative Methodology*: Employing a corpus-based approach to ensure accuracy and comprehensiveness.

Practical Application: Demonstrating the tool's practical utility through empirical validation.

3. Methodology

A Concise Overview

In order to comprehensively trace and consequently ascertain the accurate morphological patterns of trilateral abstract geminate verbs, a meticulous examination of the al-Qāmūs al-muHīT dictionary was undertaken to compile these verbs. Whenever the required data was lacking in this reference, two additional classical dictionaries were consulted: lisān al-çarab by Ibn ManĎūr and tāj al-çarūs min jawāhir al-qāmūs by az-Zabīdi.

This compilation formed the fundamental corpus for this research, encompassing 562 entries along with their morphological conjugations. These were meticulously entered into a database, serving as the core dataset for developing the software program (*application*). Subsequently, the entire corpus was entrusted to a programmer well-versed in both programming and Arabic language nuances. The programmer was briefed on the project's objectives and how the data should be manipulated to accurately determine morphological patterns and establish connections between relevant sounds and verb patterns.

Phases of the Research Project

A corpus encompassing all the trilateral abstract geminate verbs sourced from the al-Qāmūs al-muHīT dictionary was meticulously compiled. These verbs, along with their conjugations, were carefully documented within a dedicated list.

- In cases where al-Qāmūs al-muHīT omitted the present tense form(s) of certain verbs, the lisān al-çarab of Ibn ManĎūr and Tāj al-çarūs of az-Zabīdi dictionaries were seamlessly referenced to bridge this informational gap.

- Multiple tables were meticulously assembled to facilitate the precise determination of the underlying morphological mechanism involved in conjugating trilateral geminate verbs.

- Each sound corresponding to a specific range of articulation was methodically addressed in two distinct manners:

- First: When the initial letter of a trilateral geminate verb falls within a particular range of articulation, its relationship with the second and third letters is documented, regardless of whether the sounds of these (second and third) letters align with the same range of articulation as the first letter.

- Second: When the second and third letters of the verb fall within a designated range of articulation, their correlation with the first letter is cataloged, irrespective of whether the sound of the initial letter matches the range of articulation of the second and third letters.

The Programming Language

For the purpose of creating the required software application, the Delphi programming language was used. This is due to the fact that Delphi is a powerful and versatile known for its proficiency in developing Windows applications with rich graphical user interfaces (GUIs). Delphi's origin dates back to the early 1990s, when Borland International introduced the language as a successor to its Turbo Pascal compiler. Over the years, Delphi has evolved into a comprehensive software development tool, enabling developers to create visually appealing and functional applications for a wide range of industries.

At its core, Delphi belongs to the category of high-level, object-oriented programming languages. This means that developers can work with reusable code structures, called objects, which represent real-world entities or concepts. Delphi supports concepts like encapsulation, inheritance, and polymorphism, allowing developers to build modular and maintainable codebases.

One of Delphi's distinctive features is its Integrated Development Environment (IDE), which provides an intuitive and streamlined platform for coding, debugging, and designing user interfaces. The Delphi IDE facilitates rapid application development by offering a visual drag-and-drop interface builder alongside a code editor. This dual approach enhances the productivity of developers, allowing them to create applications efficiently.

Through its support for the Windows API (Application Programming Interface), Delphi applications can tap into the full range of native Windows functionalities, offering seamless integration with the underlying operating system.

Furthermore, Delphi is well-equipped to handle database interactions. Its integration with various database systems, such as Microsoft SQL Server and MySQL, enables developers to build data-driven applications with ease. Delphi's reliance on the ActiveX Data Objects (ADO) technology facilitates efficient data manipulation and retrieval.

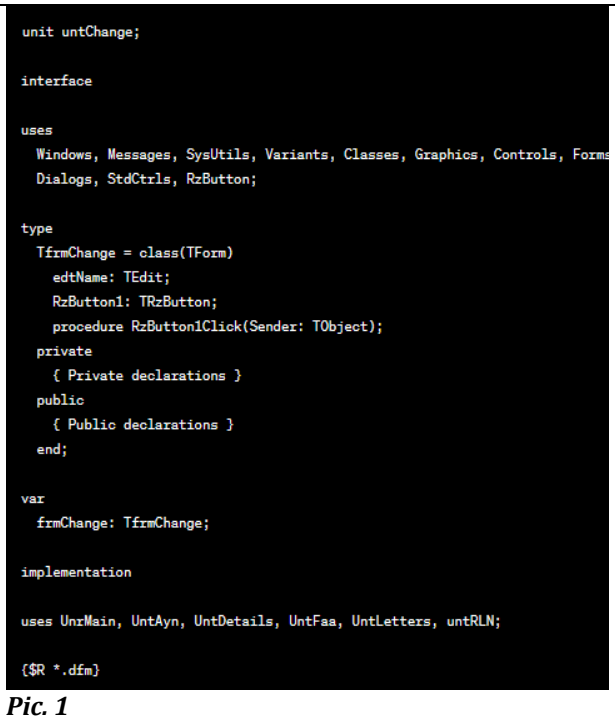
The Source code

One aspect of the source code used in the application pertains to the main form of the application, known as TFrmMain, which serves as the central hub for user interactions. The form comprises various graphical elements such as buttons, images, and panels, which users can interact with. The code is responsible for managing these interactions and controlling the behavior of the form. It contains a series of event handlers that respond to user actions, such as clicking buttons or resizing the form.One notable aspect of the code is the integration of a resizing mechanism facilitated by the FormResizer component. This ensures that the graphical elements on the form adapt appropriately when the form's dimensions change, providing a consistent user experience across different screen sizes.Additionally, the code demonstrates database integration using the ActiveX Data Objects (ADO) technology. It interacts with a database, likely storing information related to the application. SQL queries are used to perform operations such as updating records and retrieving data.A significant portion of the code is dedicated to managing control captions. These captions are the visible text labels associated with buttons, labels, and other user interface elements. The Init_Comps procedure customizes these captions based on the form's name, thereby allowing for dynamic and user-friendly interfaces.Furthermore, the code exhibits the utilization of context menus, particularly the PopupMenu1 component. Context menus provide users with additional options when right-clicking on certain elements. In this case, the context menu facilitates the modification of control captions, enhancing the application's flexibility.

Lastly, the code employs functions to search and highlight text within a rich text editing component. These functions are designed to enhance the user's ability to locate specific content within a text area and can be crucial for applications dealing with extensive textual data.

Code Example and Explanation

```
unit untChange;
interface
uses
 Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
 Dialogs, StdCtrls, RzButton;
type
 TfrmChange = class(TForm)
  edtName: TEdit;
  RzButton1: TRzButton;
  procedure RzButton1Click(Sender: TObject);
 private
  { Private declarations }
 public
  { Public declarations }
 end;
var
 frmChange: TfrmChange;
implementation
uses UnrMain, UntAyn, UntDetails, UntFaa, UntLetters, untRLN;
{$R *.dfm}
```



Pic. 1

1. The unit untChange; statement marks the beginning of the Delphi unit for the form.

2. The uses clause imports various units that provide access to different components and classes needed for the form's functionality, such as Windows, Messages, SysUtils, Variants, and others.

3. The TfrmChange class declaration defines the form itself. It contains visual components such as an edit box (edtName) and a button (RzButton1).

4. procedure RzButton1Click(Sender: TObject); is an event handler for the click event of RzButton1. When the button is clicked, it updates a database record using the content of the edtName edit box.

5. The implementation section contains the actual implementation of the form's methods and event handlers.

6. The {$R *.dfm} directive tells the Delphi compiler to include the form's visual layout information stored in a resource file.

7. The uses clause in the implementation section imports various units that seem to be part of a larger application. These units include functionality for database interactions and other forms, such as UnrMain, UntAyn, UntDetails, UntFaa, UntLetters, and untRLN.

8. The RzButton1Click procedure updates a field named 'cap' in a dataset (FrmMain.qryDumy) with the value entered in the edtName edit box. It then posts the changes to the dataset and closes the form.

In summary, the provided code defines a Delphi form TfrmChange with an edit box and a button. The button click event handler updates a database record's field with the value entered in the edit box. The code is related to database interactions and seems to be part of a larger application with multiple forms and functionalities.

Software Processing of Morphological Data and Computational Methods Employed

This section addresses the underlying algorithms, data structures, and computational methods employed by the software.

Data Structures and Initialization

The software begins by defining various units and classes that handle different aspects of the morphological analysis. These units include UnrMain, UntAyn, UntFaa, UntDetails, and others, each responsible for specific tasks such as form creation, data handling, and user interface management.

Unit Initialization:

- **UnrMain**: Initializes the main form and manages form resizing, button clicks, and database connections.
- **UntAyn**: Handles the morphological data for the 'Ayn' part of the verb and interacts with the database to fetch and display relevant data.
- **UntFaa**: Similar to UntAyn, but focuses on the 'Faa' part of the verb.
- **UntDetails**: Manages detailed views and interactions related to specific morphological entries.

Database Interaction

The software uses an ADO (ActiveX Data Objects) connection to interact with a database that stores morphological data. Queries are executed to fetch, update, and manipulate this data based on user inputs and software requirements.

Key Components:

- **TADOQuery**: Executes SQL queries to fetch data from the database.

- **TADOTable**: Represents tables within the database and provides methods to manipulate the data.

Example SQL Operations:

- Fetching data: SELECT ID, Wrd, Txt1, Txt2 FROM T4th WHERE (Wrd='some_word');
- Updating data: UPDATE Rel2 SET Rel2.BabSarfy = 'new_value' WHERE (ID=241);

Morphological Analysis Algorithms

The core functionality of the software involves analyzing morphological patterns and categorizing verbs accurately. The software processes inputs by reading files containing morphological data, applying transformation rules, and updating the user interface with the results.

File Reading Functions:

- readFileR, readFileL, readFileN: Functions to read specific types of morphological data files and populate the internal data structures with this information.

Example Function:

```pascal
Function TfrmRLN.readFileR(c : string) : Boolean;
var
  I, ID: Integer;
  flag : Boolean;
  sqlstr, source : String;
Begin
  ID := 1;
  memTree.Append;
  memTreeID.Value := ID;
  memTreeParentID.Value := 0;
  memTreeItem.Value := Edit1.Text;
  memTree.Post;
  ID := ID + 1;

  flag := False;
  sqlstr := 'SELECT ID, LName, LValue, LText FROM r WHERE (((LName)='+QuotedStr(C)+'))'
  With qryDumy Do
  Begin
    Close;
    SQL.Text := sqlstr;
    Open;
    While Not Eof Do
    Begin
      // Processing logic
      Next;
    End;
```

Pic. 2

User Interface and Interaction

The user interface is managed through forms and various controls such as buttons, labels, panels, and grids. These components are dynamically updated based on user interactions and the results of morphological analysis.

Key Components:

- **TForm**: Base class for forms used in the application.
- **TPanel**: Container for other controls, used to organize the layout.
- **TRzButton**: Enhanced button control for user interactions.
- **TRxRichEdit**: Rich text editor for displaying and highlighting morphological data.

Example Interaction:

```pascal
procedure TFrmMain.RzButton1Click(Sender: TObject);
begin
  frmRLN.ShowModal;
end;
```

Pic. 3

Advanced Features

*Search and Highlight***:** The software includes functions to search for specific text within rich edit controls and highlight the results.

```pascal
function SearchForText_AndSelect(RichEdit: TRxRichEdit; SearchText: string): Boolean;
var
  StartPos, Position, Endpos: Integer;
begin
  StartPos := 0;
  with RichEdit do
  begin
    Endpos := Length(RichEdit.Text);
    Lines.BeginUpdate;
    while FindText(SearchText, StartPos, Endpos, [stMatchCase]) <> -1 do
    begin
      Position := FindText(SearchText, StartPos, Endpos, [stMatchCase]);
      Inc(StartPos, Length(SearchText));
      SetFocus;
      SelStart  := Position;
      SelLength := Length(SearchText);
      SelAttributes.Color := clRed;
      SelAttributes.Style := [fsBold];
    end;
    Lines.EndUpdate;
  end;
end;
```

Pic. 4

*Dynamic Updates***:** Forms and controls are dynamically resized and updated to fit the data and user interactions.

```pascal
procedure TFrmMain.FormResize(Sender: TObject);
begin
  FormResizer.ResizeAll;
end;
```

Pic. 5

Application Architecture and Components

The core components of the application include:

1. **Forms and User Interface (UI) Components**: Various forms (TFrmMain, TFrmAyn, TFrmFaa, TFrmLetters, TFrmDetails, TfrmEqua, TfrmChange, TfrmRLN) serve specific purposes, such as displaying data, handling user inputs, and managing database interactions. These forms utilize a range of UI components like buttons, labels, edit boxes, rich edit controls, panels, images, and tree views to create an interactive user experience (Embarcadero Technologies, n.d.; Pacheco & Teixeira, 2000).

2. **Database Components**: The application employs TADOQuery components for executing SQL queries and TRxMemoryData for in-memory data storage. This setup allows for efficient data retrieval, manipulation, and display, ensuring that users have access to real-time information (Jensen, 2001; Microsoft, n.d.).

3. **Graphical Representation**: The UDrawArrows unit provides functions for drawing arrows and connecting controls on a canvas, enhancing the application's ability to visually represent relationships and data flows. This is particularly useful for creating diagrams and visual aids that help users understand complex data structures (Embarcadero Technologies, n.d.; Levine, 1995).

Key Functionalities

1. **Data Management**: The application excels in managing hierarchical and relational data. It uses tree views (TJvDBTreeView) to represent hierarchical data structures, making it easy for users to navigate and understand relationships between different data points. The forms dedicated to specific data types (e.g., letters, categories) allow for organized data entry and editing (Embarcadero Technologies, n.d.; Cantu, 2003).

2. **Graphical Visualization**: Visualization is a standout feature of the application. The UDrawArrows unit enables the drawing of arrows and connections, facilitating the creation of visual diagrams that represent data relationships and workflows. This feature is particularly valuable in educational and research settings, where visual aids can significantly enhance understanding (Embarcadero Technologies, n.d.; Peterson, 1996; Brosius, 2020).

3. **User Interaction**: User interaction is facilitated through various UI components and event handlers. The application supports dynamic data loading and real-time updates, ensuring that users can interact with the data seamlessly. Button click handlers and custom methods for reading and processing data enhance the user experience by providing intuitive and efficient ways to manage and visualize data (Pacheco & Teixeira, 2000; Field, 2012).

Potential Use Cases

1. **Linguistic and Textual Data Processing**: The application is well-suited for managing linguistic and textual data, making it an excellent tool for researchers and educators in language studies. By organizing data into hierarchical structures and providing robust visualization tools, it helps users analyze and understand complex linguistic relationships (Field, 2012; Brosius, 2020).

2. **Educational and Research Tool**: In academic settings, the application can serve as a valuable educational tool. It enables students and researchers to visualize hierarchical and relational data,

facilitating a deeper understanding of complex concepts. The ability to create and manipulate data diagrams makes it an effective teaching aid (Brosius, 2020; Field, 2012).

3. **Project and Workflow Management**: The application's capabilities extend to project and workflow management. By visualizing tasks and dependencies as connected nodes, project managers can plan, track, and manage workflows more effectively. The graphical representation of workflows helps teams understand project structures and dependencies, improving collaboration and efficiency (Kerzner, 2017).

Significance of the Program (Software Application)

This program is poised to make a profound impact on the realm of language instruction, asserting its relevance within applied and computational linguistics alike. At its core, the program seeks to precisely pinpoint the accurate vowel sound affiliated with the middle (second) letter of Arabic trilateral abstract verbs when conjugated in the present tense. This culminates in the precise determination of the morphological pattern to which each verb corresponds, effectively eradicating any potential for error. Distinguished by its novelty, this user-friendly software program is tailor-made to offer learners and users of the Arabic language the correct morphological insights they require. The combination of a corpus-based approach, empirical validation, and practical utility underscores the significance and impact of this work.

The success of this software opens avenues for further research and development in several areas:

1. *Extension to Other Verb Categories*: Expanding the tool to cover other complex verb categories in Arabic.

2. *Integration with NLP Applications*: Incorporating the tool into broader NLP applications to enhance machine translation, speech recognition, and other language processing tasks.

3. *Cross-Linguistic Applications*: Adapting the methodology to analyze and process morphologically rich languages other than Arabic.

The research presented in this paper situates itself within the broader context of computational linguistics and morphological analysis by addressing a specific challenge in Arabic verb morphology. By developing a unique and patented tool for the analysis of trilateral geminate verbs, the research advances the field and provides valuable insights for future developments in Arabic NLP and beyond.

Research Terminology

The software program employs the subsequent terms when utilized to retrieve the accurate morphological pattern of the verbs under scrutiny. The search outcome presents a comprehensive description of sound attributes and associated information. It is noteworthy that classical and modern phoneticians have employed varying terminology to label certain attributes (Refer to Appendix III for details).

Point of Articulation[6] **:** This denotes the juncture where two or more speech components convene, thereby channeling air to produce a specific sound. For instance, the Arabic /b/ and /m/ share a bilabial point of articulation, while /q/ is uvular, and /s/ is alveolar.

Range of Articulation[7] **:** An area encompassing multiple adjacent points of articulation. Sounds produced within a given range typically exhibit analogous traits. For instance, the pharyngeal range accommodates the Arabic /h/ and glottal /c/, both of which articulate at the throat entrance (base of the throat) at the level of the larynx. Meanwhile, /ç/ and /H/ manifest in the middle throat, and / ɣ/ and /x/ emanate from the uppermost (end) portion of the throat.

[6] C.f., Ibn Yaçīš (n.d.), v.10, p.124.
[7] In his book, *Kitāb al-çayn,* Al-Xalīl often used this term. See pp. 64-65

Voiceless Sound [8] **:** A sound devoid of vocal cord vibration during production. Examples encompass /s/, labiodental /f/, and interdental /θ/.

Voiced Sound [9] : A sound engendered through the vibration of the vocal cords. Instances include the alveolar /z/ and interdental /ð/.

Plosive (Stop) Sound [10] : This sound results from a momentary halt in airflow at the point where two speech components meet, followed by an abrupt release of air. Examples encompass Arabic uvular /q/, velar /k/, alveolar /t/, and bilabial /b/.

Fricative (Lax) Sound **:** A fricative sound emerges when two articulators nearly touch, partially obstructing the airstream and causing turbulent airflow.[11] Instances comprise Arabic pharyngeal /h/, alveolar /z/, and labiodental /f/.

Liquids [12] : Liquid sounds arise when two articulators close but allow airflow without creating whistling or friction. Examples involve Arabic /l/, /n/, /r/, and, according to Sībawayh, /ς/.[13]

Velarization [14] **:** This occurs when the tongue elevates towards the soft palate, curving and amplifying the sound. Examples encompass Arabic /S/, /D/, and /T/.

Non-Velarization[15] **:** The opposite of velarization; mouth cavity is reduced compared to velarized sounds. Examples include velar /k/, /t/, and alveolar /d/, per classical Arabic phoneticians.

Istiʿlāᶜ [16] **:**This arises when the tongue is raised towards the upper palate, accompanied by or without velarization. Examples encompass Arabic /x/, / γ/, /q/, /S/, /D/, /T/, and /Ď/.

Istifāl [17] **:** The contrary of Istiʿlāc, occurring when the tongue lowers in the mouth. All Arabic sounds, except those of Istiʿlāc, fall under the Istifāl category.

Elongated Sounds **:** This category includes Arabic /š/ and /D/, sharing the same range of articulation[18] and elongation attribute.[19]

Hushing [20] **:** Represented by /š/, where the tongue's front raises, generating a fricative hushing sound.

Trill (Sonorant) [21] **:** Exemplified by /r/, vibrations between active and passive articulators produce this sound, sans turbulent airflow.

Nasalization **:** It occurs when the soft palate lowers, allowing air to escape through the nose.[22] In Arabic, only labial /m/ and gliding /n/ exhibit nasalization.

---

[8] C.f., Ibn Ginni, 1954, v.1, p.60, As-saçarān, n.d., p.88.
[9] C.f. Sībawayh, 1982, v.4, pp. 434.
[10] C.f., Sībawayh, 1982, v.4, pp. 434; MaSlūH, p.175; As-saçarān, n.d., p.153.
[11] MaSlūH, 2000, p.184.
[12] See Sībawayh, 1982, v.4, pp. 435. Ibn Ginni (1954, v.1, p.61) states that those letters are eight, namely, /a, ς, y, l, n, r, m, w/.
[13] C.f. Sībawayh, 1982, v.4, pp. 434.
[14] C.f. Ibn Yaçīš (n.d.), v.10, p.128. See also, çumar, 1991, p.326.
[15] C.f. Sībawayh, 1982, v.4, pp. 436.
[16] C.f. Ibn Ginni, 1954, v.1, p.62.
[17] C.f. Ibn Ginni, 1954, v.1, p.62.
[18] C.f. Sībawayh, 1982, v.4, pp. 457; Al-Mubarrid, 1399AH, v.1, p.192; Ibn Ginni, 1954, v.1, p.47; Ibn Yaçīš (n.d.), v.10, p.125.
[19] C.f. Sībawayh, 1982, v.4, pp. 457; Ibn Yaçīš (n.d.), v.10, p.141.
[20] C.f. Sībawayh, 1982, v.4, pp. 448; Ibn Yaçīš (n.d.), v.10, pp.125 and 140; çumar, 1991, p.317.
[21] C.f. Sībawayh, 1982, v.4, pp. 435; Ibn Ginni, 1954, v.1, p.63; Malmberg, 1994, p.94; As-saçarān, n.d., p.171; Bišr, 1970, p.161.
[22] As-saçarān, n.d., p.168; Malmberg, 1994, p.91; Bišr, 1970, p.167.

Lateralization **:** Represented by /l/, where the tongue's tip adheres to the middle alveolar ridge, permitting air to escape from the sides, sometimes unilaterally.[23]

Discussion and Findings

The software program, developed based on the comprehensive corpus comprising 562 morphological entries, has demonstrated its efficacy in determining the morphological classifications of trilateral geminate verbs consisting of consonant sounds.

As the software program relies on an authenticated corpus sourced from renowned classical encyclopedic dictionaries, an additional stride was taken to assess the program's relevance among Arabic learners and users, as detailed below.

A comprehensive testing protocol was devised, encompassing diverse categories of learners and users. Commencing in 2021 during the height of the COVID-19 pandemic and travel restrictions, the program underwent testing twice: initially with a group in Egypt, composed of non-native Arabic learners, Egyptian university graduates from non-Arabic disciplines, and a cohort of online participants. Subsequently, in 2022, with the relaxation of travel bans, a more extensive pool of students and research subjects was engaged, encompassing individuals from various universities and institutions.

The random sample encompassed 119 participants, categorized as follows:

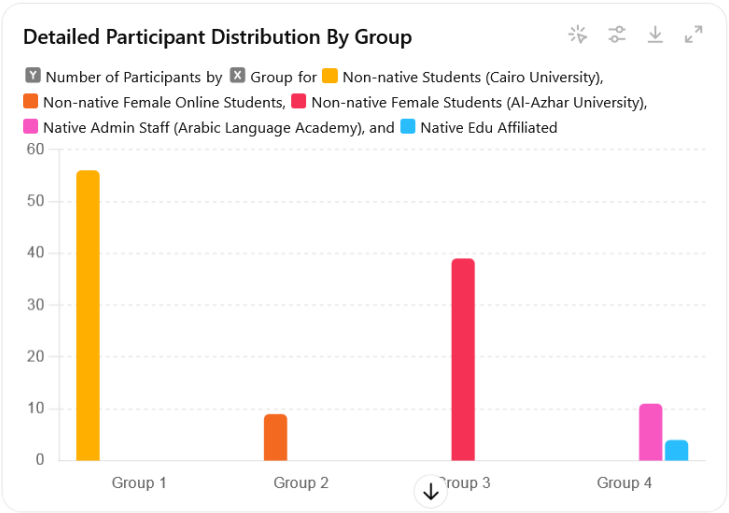
1. Group 1: Comprising 56 male and female non-native students studying Arabic at Cairo University's Faculty of Arts.

2. Group 2: Encompassing 9 female non-native students engaged in online Arabic studies.

3. Group 3: Comprising 39 female non-native students enrolled at Al-Azhar University.

4. Group 4: Consisting of 15 native Arabic speakers, Egyptians who were non-specialists; of these, eleven were administrative staff at the Arabic Language Academy, while the remaining four were affiliated with an educational institution.

Each participant within these groups was administered a distinct test featuring 10 trilateral geminate verbs conjugated in the past tense. Their task involved correctly identifying the present tense form of each verb and accurately applying the requisite diacritics corresponding to the verb's letters. This exercise aimed to gauge the level of accurate application and the potential need for the software program.



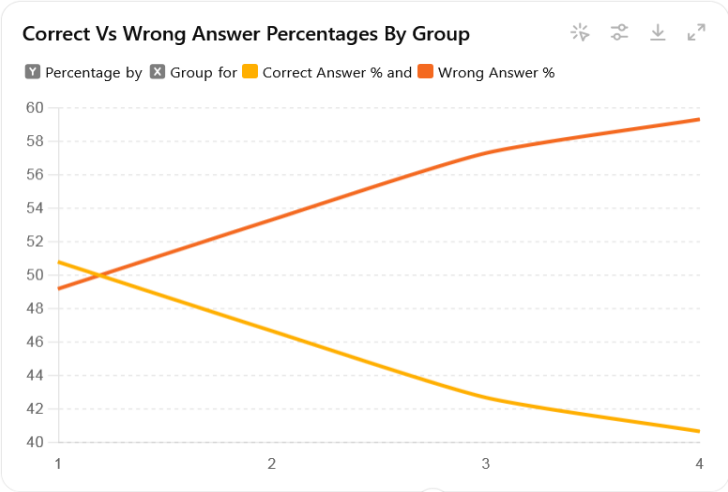
Pic. 6

The ensuing outcomes were as follows:

[23] As-saçarān, n.d., p.169; Bišr, 1970, pp.166-167; MaSlūH, 2000, p.180-181; Malmberg, 1994, pp.92-93.

Group	Correct Answer %	Wrong Answer %
1	50.8	49.2
2	46.67	53.33
3	42.69	57.31
4	40.67	59.33

Table 4



Pic. 7

The findings demonstrate a range of correct responses spanning between 40.67% and 50.80%. This starkly underscores the actual challenges involved in determining the present tense form of the specific verb category under examination. The outcomes not only underscore the indispensability of the proposed software program, intended for both native and non-native users of Arabic, but also emphasize its significance in averting linguistic errors. The successful achievement of the primary research objective pertaining to Arabic proficiency is unequivocal. Evidently, the existing competencies across the entire sample exhibit significant deficiencies, warranting substantial enhancement. This underscores the imperative need for a tool—namely, the software program—to rectify this shortcoming, which the program effectively accomplishes.

To realize the second objective and address the pertinent question outlined above, a meticulous endeavor was undertaken to accurately identify and compile all trilateral geminate verbs conforming to multiple present tense patterns. The al-Qāmūs al-muHīT, lisān al-ɕarab, and tāj al-ɕarūs dictionaries were consulted for this purpose, rigorously examining the pertinent verbs. The aim was to ascertain whether certain verbs bore polysemous characteristics, with each possible pattern carrying distinct meanings. Additionally, the inquiry sought to determine which verbs adhered to a single pattern and which exhibited variations.

This exhaustive exploration culminated in the classification of these verbs into four distinct categories, as delineated below:

1) Verbs whose diverse morphological patterns entail distinct semantic meanings.

Examples:

هشّ	عزّ	حشّ	غضّ	خرّ	قرّ	جدّ	شقّ	صكّ	سدّ
hašša	ɕazza	Hašša	ɣaDDa	xarra	qarra	jadda	šaqqa	Sakka	sadda
زفّ	طلّ	دقّ	ذمّ	رمّ	نمّ	فلّ	بلّ	مرّ	

zaffa	Talla	daqqa	ðamma	ramma	namma	falla	balla	marra	

Table 5

2) Verbs whose different morphological patterns are semantically the same.

Examples:

أزّ	عجّ	حبّ	كعّ	شحّ	شجّ	شذّ	ضنّ
ᶜzza	çajja	Habba	kaççа	šaHHa	šajja	šaðða	Danna
طشّ	رثّ	فحّ	مصّ	مسّ	خسّ	محّ	
Tašša	raθθa	faHHa	maSSA	massa	xassa	maHHa	

Table 6

3) Verbs exhibiting morphological patterns that are semantically partial. In essence, certain patterns converge in specific meanings, while differing in others.

Examples:

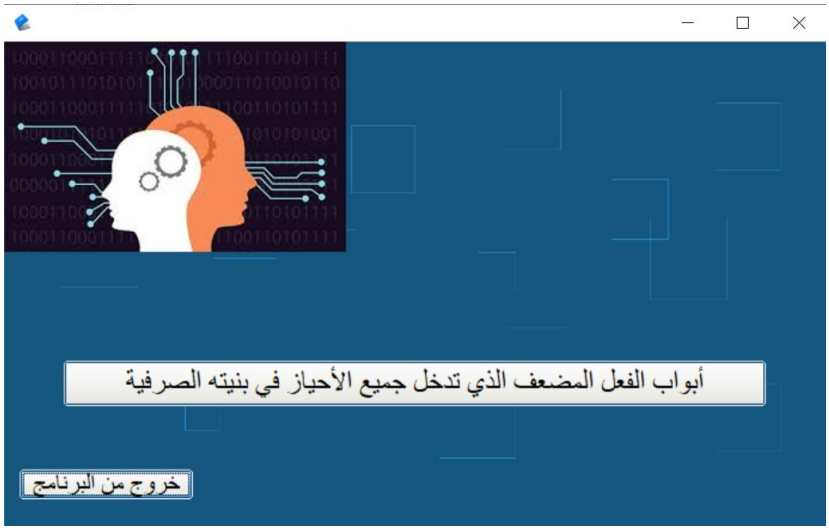
أصّ	ألّ	أبّ	علّ	عنّ
ᶜaSSa	ᶜalla	ᶜabba	çalla	çanna
حقّ	غثّ	قزّ	شدّ	
Haqqa	ɣaθθa	qazza	šadda	

Table 7

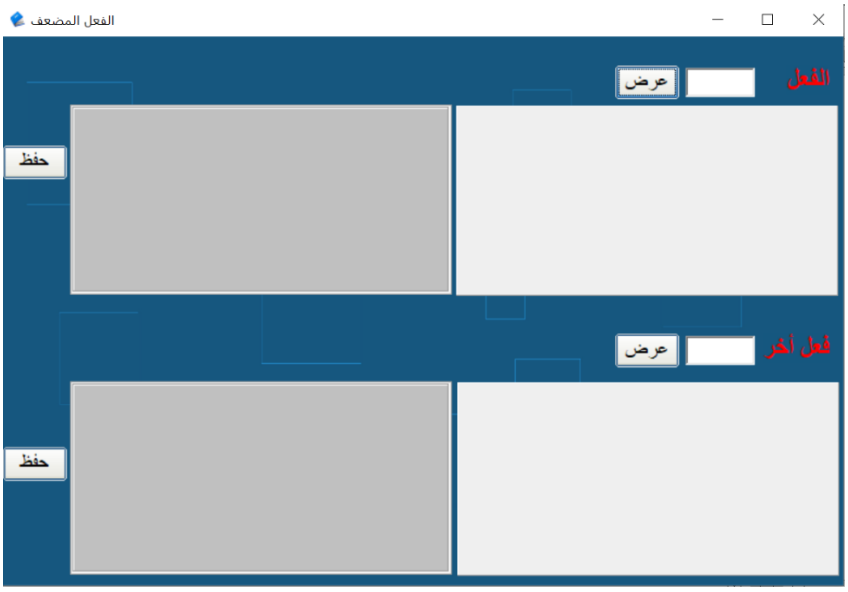
4) Verbs displaying distinct patterns that yield semantically identical outcomes in most or all patterns, while each harboring unique morphological or semantic characteristics.

Examples:

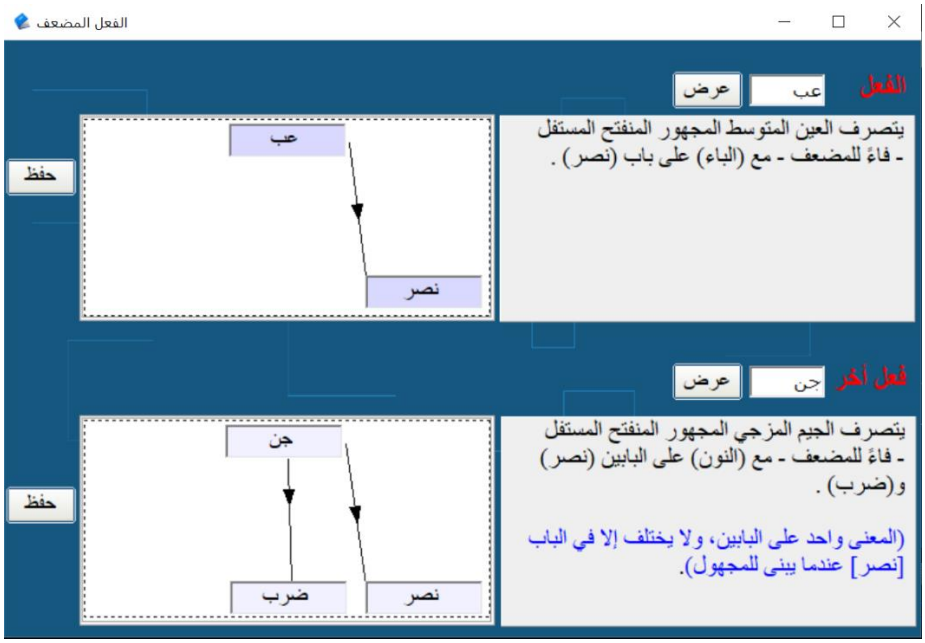
- The verb /janna/ adheres to the morphological patterns of both /naSara/ and /Daraba/, resulting in the same meaning across both patterns, except in the passive voice.
- The verb /šaççа/ conforms to the morphological patterns of /naSara/ and /Daraba/, yielding identical meanings in both patterns. However, it functions transitively in one pattern and intransitively in the other.
- The verb /šaðða/ adopts the morphological patterns of /naSara/ and /Daraba/, generating matching meanings in both patterns. Yet, the transitive form follows the /naSara/ pattern, while the intransitive form aligns with the /Daraba/ pattern.
- The verb /batta/ utilizes the morphological patterns of both /naSara/ and /Daraba/, producing largely consistent meanings in both. Nevertheless, one of the meanings attributed to the /Daraba/ pattern differs from the shared meanings of the two forms.



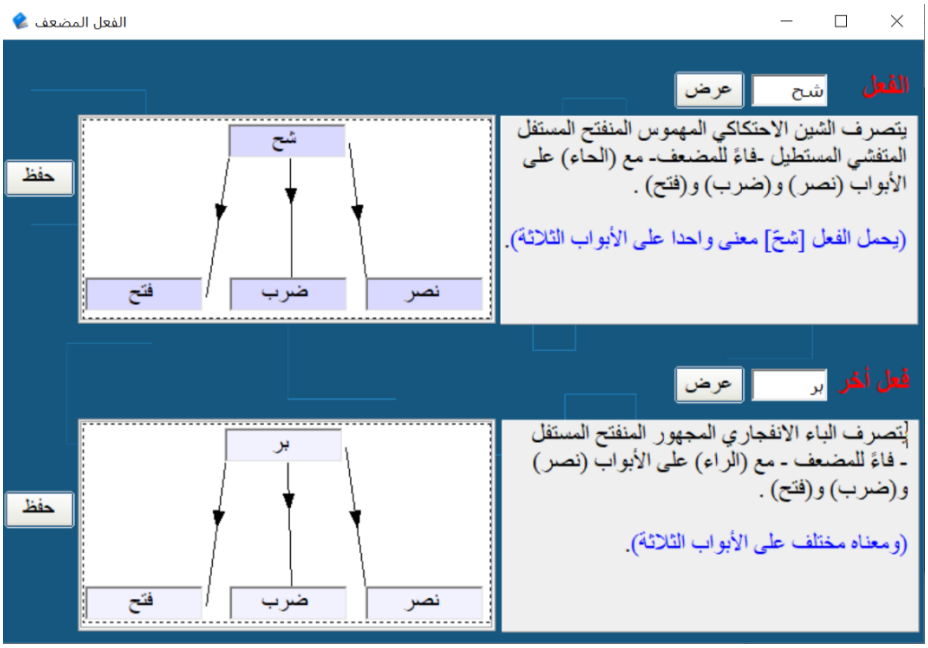
Pic. 8: The Program Interface



Pic. 8: The user-friendly entry screen where the verb(s) in question may be entered in the small pane.



Pic. 10: The result screen showing the information provided by the program and relevant morphological pattern(s) chart(s).



Picture 11: The result screen allows for searching for more than one verb and allows result saving.

It is crucial to acknowledge that this study stands as an unparalleled endeavor within the realm of the Arabic language. With its expansive scope and notable accomplishments, it is anticipated that this work will serve as a trailblazing catalyst for further explorations encompassing the remaining trilateral verb categories in Arabic. Such endeavors hold the promise of rendering Arabic more approachable for all its users—be they learners, media professionals, or others. The introduction of a user-friendly software program, adept at navigating the intricacies of a complex morphological patterning process, is a commendable undertaking, particularly when applied to a language steeped in historical legacy and tradition. The prospect of mitigating errors through such an innovative tool is certainly a welcome advancement, particularly within the context of a language characterized by its deep historical and traditional roots.

Conclusion

In summation, the culmination of this research endeavor is a testament to the intricate and multifaceted nature of the Arabic language's morphological patterns, particularly when examining the trilateral abstract geminate verbs. This study's comprehensive investigation into the complexities of determining accurate morphological categories for these verbs has yielded invaluable insights into the challenges faced by both native and non-native Arabic speakers. The software program developed as a result of this study represents a pioneering achievement in computational linguistics, aiming to alleviate the persistently daunting task of discerning the correct morphological patterns for these verbs.

The empirical findings of this study, derived from a meticulously curated corpus comprising 562 morphological entries, underline the pressing need for a solution to address the prevalent difficulties in mastering these verb categories. With correct answers ranging between 40.67% and 50.80%, it is evident that even amongst educated language users, accurately identifying the present tense form for these verbs remains a substantial challenge. This underscores the limitations of existing linguistic competencies and the necessity for an innovative tool to bridge this gap. The software program, marked by its meticulous corpus-based approach, not only serves as a crucial resource for learners and users of the Arabic language but also highlights the inherent complexity of Arabic verb morphology.

Furthermore, the successful implementation of this software program is indicative of its potential to revolutionize language pedagogy and computational linguistics. By providing a systematic method for resolving the intricate complexities of morphological patterns, the program offers a transformative opportunity for educators, learners, and researchers alike. It serves as a cornerstone for future initiatives aiming to streamline the learning process of other verb categories and enhance the overall proficiency of Arabic users across various domains.

It is worth emphasizing the broader implications of this research. The incorporation of state-of-the-art technology to address linguistic challenges underscores the harmonious synergy between traditional linguistic scholarship and modern computational techniques. The software program, while advancing linguistic research and pedagogical methods, preserves the essence of a language deeply entrenched in historical and cultural significance. This nuanced balance between tradition and innovation encapsulates the essence of the Arabic language itself.

In retrospect, this study's accomplishments extend beyond its immediate scope. The meticulous analysis and meticulous categorization of trilateral abstract geminate verbs offer an intellectual framework that invites future investigations into the intricate interplay between morphological patterns and semantic meanings. The diverse categories unearthed through this research—ranging from semantically distinct patterns to those with partial or shared semantics—underscore the linguistic richness of the Arabic language.

The research represents a significant advancement in Arabic linguistics, offering an innovative software program that addresses the complex task of identifying morphological patterns in trilateral abstract geminate verbs. The program's development, underpinned by a comprehensive corpus and empirical validation, highlights the critical need for such a tool in both educational and computational contexts. By bridging the gap in existing linguistic competencies, the software enhances the learning process and proficiency of Arabic users.

Looking ahead, the future potential of integrating the developed software with artificial intelligence (AI) and machine learning algorithms can be explored to enhance its predictive accuracy and adaptability. AI can potentially provide personalized learning experiences and adaptive feedback to users based on their individual performance and learning pace. This integration can also allow the software to evolve and improve continuously as it interacts with more users and processes more data.

References

[1] Al-Farāhīdī, Al-Xalīl ibn ᶜAHmad. (1967). *Kitāb al-çayn, ᶜawwal muçjam fīl-luɣat il-çarabiyyah*. (taHqīq çabdullah darwiš). Baghdad: Al-çanī Printing House.
[2] Al-Fayrūzabādī, Majduddīn MuHammad ibn Yaçqub. (n.d). *al-Qāmūs al-muHīT.* (no place of publication): Arab Book Publishing House.
[3] Al-Istrābāði, RaDiyy-uddīn MuHammad ibn al-Hasan. (1982). *šarH šāfiyat Ibn al-Hājib*. (taHqīq az-Zaffāf). Beirut: dār al-kutub al-çilmiyyah.
[4] Al-Mubarrid, ᶜAbul-çabbās MuHammad ibn Yazīd. (1399 AH). *Al-MuqtaDab.* Cairo: Supreme Council of Islamic Affairs.
[5] Al-XaTīb, çabdul-laṭīf MuHammad. (2003) *Al-mustaqSā fī çilm it-taSrīf*. Kuwait: Al-çurūbah House for Publishing and Distribution.
[6] As-saçarān, MaHmūd. (n.d.). çilm *al-luɣah: Muqaddimah lil-Qāriᶜ al*-çarabī. Beirut: dār al-nahDah *al*-çarabiyyah for Printing and Publishing.
[7] Az-Zābīdi, MuHammad MurtaDā al-Husaynī. (1986). *Attakmilah wað-ðayl waS-Silah limā fāta SaHib al-qāmūs min al-luɣah*. (taHqīq MuStafā Higāzī; Revised by MuHammad Mahdī çall-am). First Edition. Cairo: General Authority of the Emiri Publications.
[8] Az-Zābīdi, MuHammad MurtaDā al-Husaynī. (1993-2001). *tāj al-çarūs min jawāhir al-qāmūs.* Vol. 27 and vol. 36. Kuwait: Arabic Heritage Series.
[9] Bišr, Kamāl. (1970). *çilm al-luɣah al-çām (al-aSwāt)*. Cairo: dār al-maçārif.
[10] Brosius, D. (2020). *Applied Data Visualization with R and Python*. Apress.
[11] Cantu, M. (2003). *Mastering Delphi 7*. Sybex Inc.
[12] Darwish, K., Mubarak, H., & Abdelali, A. (2014). Farasa: A Fast and Accurate Segmenter for Arabic. *LREC*.
[13] Embarcadero Technologies. (n.d.). *Delphi Graphics and Drawing*. Retrieved from https://www.embarcadero.com/products/delphi
[14] Embarcadero Technologies. (n.d.). *Delphi User Interface Design*. Retrieved from https://www.embarcadero.com/products/delphi
[15] Field, A. (2012). *Discovering Statistics Using R*. SAGE Publications Ltd.
[16] Habash, N. (2010). *Introduction to Arabic Natural Language Processing*. Morgan & Claypool Publishers.
[17] Habash, N., & Rambow, O. (2006). MAGEAD: A Morphological Analyzer and Generator for the Arabic Dialects. *Proceedings of the 21st International Conference on Computational Linguistics and the 44th annual meeting of the Association for Computational Linguistics*.
[18] Ibn Ginni, ᶜAbul-FatH çuθmān. (1954). *Sir Sināçat il-ᶜiçrāb*. (taHqīq MuStafā As-saqqā). First Edition. MuStafā Al-bābi Al-Halabi Publishing House.
[19] Ibn ManĎūr, Jamāuddīn ᶜAbul-FaDl MuHammad. (1981). *Lisān al*-çarab. Cairo: dār al-maçārif.
[20] Ibn Yaçīš , Muwaffaq-uddīn Yaçīš ibn çali. (n.d.). *šarH al-mufaSSal*. Beirut: çālam al-kutub.
[21] International Phonetic Association. (2012). *Handbook of the International Phonetic Association*. 13th edition. Cambridge: Cambridge University Press.
[22] Jensen, M. (2001). *Advanced Delphi Developer's Guide to ADO*. Wordware Publishing Inc.
[23] Kerzner, H. (2017). *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. Wiley.
[24] Levine, J. R. (1995). *Graphics File Formats*. Windcrest/McGraw-Hill.
[25] Malmberg, Bertil. (1994). *Phonetics*. Trans. Muhammad H. Hulayyil. Cairo: Ain for Humanitarian and Social Studies and Research.
[26] MaSlūH, saçd çabdul-çazīz. (2000). *dirāsat as-samç wal-kalām*. First Edition. Cairo: çālam al-kutub.
[27] Microsoft. (n.d.). *ADO (ActiveX Data Objects) API Reference*. Retrieved from https://docs.microsoft.com/en-us/sql/ado/ado-api-reference
[28] Pacheco, X., & Teixeira, S. (2000). *Delphi Developer's Guide*. Sams Publishing.
[29] Pasha, A., Al-Badrashiny, M., Mohammed, Y., Rambow, O., & Habash, N. (2014). MADAMIRA: A Fast, Comprehensive Tool for Morphological Analysis and Disambiguation of Arabic. *LREC*.
[30] Peterson, E. (1996). *Graphics Programming with Delphi*. Sams Publishing.

[31] Sībawayh, ᶜAbū bišr çamr ibn çuθmān ibn Qanbar. (1982). *Al-kitāb*. Vol. 4. Second Edition. Cairo: maktabat al-xānji.
[32] çumar, ᶜAHmad Muxtār. (1991). *dirāsat aS-Sawt al-luɣawi*. Cairo: çālam al-kutub.

Ahmed Allaithy

Professor of Translation and Head of the Department of Arabic and Translation Studies at the American University of Sharjah. He has a PhD in Comparative Translation, University of Durham, UK. He is also the current President of Arabic Translators International (ATI). He is the General Editor of ATI Academic Series, and ATI Literary Series (Arabic Literature Unveiled). His research areas are Translation & Interpreting Studies, Language Acquisition, Linguistics, Arabic Rhetoric, Islam, Qur'anic Studies and intercultural communication.

Appendix I

Test samples to measure the accuracy of determining the correct present tense form of the trilateral geminate abstract verbs in Arabic – (For Non-Native Speakers)

Name …….. Degree …….. Institution …….. Year ……..

م	الفعل الماضي	الفعل المضارع منه	حدد حركة الحرف الأوسط من الفعل المضارع		
			الضمة	الفتحة	الكسرة
مثال	حَـطّ	يَحُطّ	✓		
1	أنَّ				
2	هَـفّ				
3	حَـجَّ				
4	قـلَّ				
5	جـزَّ				
6	شـفَّ				
7	ضَـجَّ				
8	صَـب				
9	تـمَّ				
10	دكَّ				

022 – Non-native Speakers)

Faculty of Arts, Cairo University

(Tests 2022 – Non-native Speaker)

Faculty of Arts, Cairo University

Measuring the accuracy in determining the correct present tense form of the trilateral geminate abstract verbs in Arabic

(16)

Name …….. Nationality …… Year …

م	الفعل الماضي	مضارعه	حركة الحرف الأوسط من المضارع		
			الضمة	الفتحة	الكسرة
مثال	حَطّ	يَحُطّ	✓		
1	شَـحَّ				
2	سَـمَّ				
3	دَلَّ				

(15)

Name …….. Nationality ……. Year …

م	الفعل الماضي	مضارعه	حركة الحرف الأوسط من المضارع		
			الضمة	الفتحة	الكسرة
مثال	عَنَّ	يَعِنّ			√
1	دبَّ				
2	طَـخَّ				
3	زجَّ				

4	رجَّ				
5	قَصَّ				
6	ضَفَّ				
7	طَشَّ				
8	حَثَّ				
9	غَصَّ				
10	حَظَّ				

(Tests 2022 – Non-native Speakers)

4	شَتَّ				
5	قَدَّ				
6	حَدَّ				
7	عَثَّ				
8	حَشّ				
9	ربّ				
10	لجّ				

ts 2022 – Non-native Speakers)

Academic Institution …… Educational Level ……

Academic Institution …… Educational Level ……

Measuring the accuracy in determining the correct present tense form of the trilateral geminate abstract verbs in Arabic

(39)

Name ……. Nationality ……. Year …

م	الفعل الماضي	مضارعه	حركة الحرف الأوسط من المضارع		
			الضمة	الفتحة	الكسرة
مثال	حَطّ	يَحُطّ	✓		
1	بَشّ				
2	شَدَّ				
3	عَضّ				
4	خَصّ				
5	لجّ				
6	صَرَّ				
7	سلَّ				
8	كَفّ				
9	ضَفّ				
10	شَتّ				

(40)

Name ……. Nationality ……. Year …

م	الفعل الماضي	مضارعه	حركة الحرف الأوسط من المضارع		
			الضمة	الفتحة	الكسرة
مثال	عَنَّ	يَعِنّ			✓
1	زَرّ				
2	طَسّ				
3	تَمّ				
4	دبّ				
5	دشّ				
6	طَفَّ				
7	حضّ				
8	رثّ				
9	نطّ				
10	متّ				

Appendix II

1- Book Cover

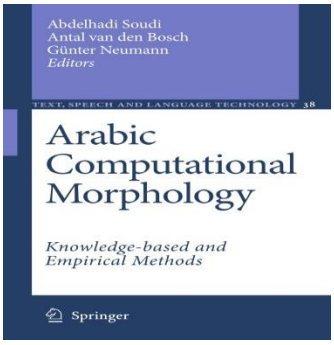
2- Transliteration System with the addition of:

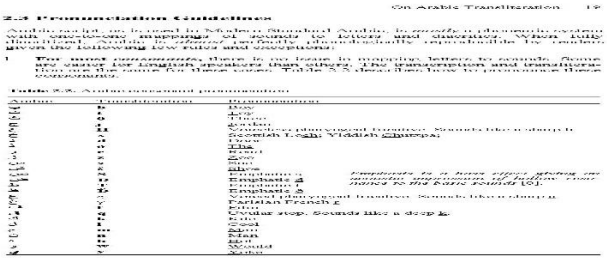
/ᶜ/ for the *hamzah*, /g/ and */ā/, /ī/, and /ū/* for the long corresponding Arabic vowel sounds.

Notes:

-The Arabic definite article /ال -al/ follows the Arabic pronunciation conventions. When unpronounced, it is dropped in the transliteration, and compensated for by the next geminate sound. For example: Az-Zabīdi, not Al-Zabīdi.

-The double/geminate adjectival /y/ at the end of names is reduced to the more common /i/; for example: Az-Zabīdi not Az-Zabīdiy.





Appendix III

The terminology used by Al-Xalīl and Sībawayh in describing the Arabic sound attributes and places of articulation (classical), together with those of modern phoneticians.

Classical	Modern	English	Description	Sounds
المخرج	المخرج	Point of articulation	نقطة التقاء عضوي النطق ليمر هواء الزفير بينهما ويحدث الصوت.	كل الصوامت
الحيز		Range of articulation	مساحة تشتمل على أكثر من مخرج، وتكون المخارج فيها متقاربة.	
صوت مجهور	مجهور	Voiced	صوت يتقارب معه الوتران الصوتيان، بحيث يسبب اندفاع هواء الزفير من الحنجرة – مارا خلالهما – تذبذبا منتظما شديدا فيهما.	**أ– ع– غ– ق– ج – ض– ل– ن– ر– ز– ط– ظ– د– ذ– ب– م**
صوت مهموس	مهموس	Voiceless (Unvoiced)	صوت يكون معه الوتران الصوتيان متباعدين، بحيث يمر هواء الزفير في منطقة الحنجرة، دون اهتزاز للوترين الصوتيين.	هـ– ح– خ– ك– ش– ص– س– ت– ث– ف
صوت شديد	انفجاري (وقفي)	Plosive (stop)	صوت ينتج عن التقاء تام لحظي بين عضوي النطق، يوقف تيار الهواء في الفم عند نقطة الالتقاء، ويتبعه تسريح فوري لهواء الزفير.	ق– ك– ج– ط– ت د– ب– أ
صوت رخو	احتكاكي	Fricative (Lax)	صوت ينطق بحدوث تقارب شديد بين عضوي النطق، ينشأ عنه تضييق ممر الهواء عند نقطة المخرج، وحدوث حفيف أو احتكاك مسموع.	هـ– ح– غ– خ– ش– ص– ض– س– ث– ف– ز– ظ– ذ
صوت متوسط	الموائع	Liquids	ينطق بالتقاء عضوين من أعضاء النطق التقاء تاما، ولكن النفَس يجد له مسربا إلى الخارج، فيمر الهواء دون أن يحدث صفيرا أو حفيفا مسموعا.	ل– م – ن– ر + (ع) عند سيبويه
صوت مستطيل		Elongated	صوتان هما الشين والضاد، ويجمعهما حيز واحد، وصفة الاستطالة.	ش– ض
صوت مطبق	مفخم	Velarized	يرتفع فيه مؤخر اللسان إلى الحنك الأعلى آخذا شكلا مقعرا؛ مما يزيد حجم تجويف الفم، ويضيق حجم تجويف الحلق أثناء إخراج الصوت، فيسمع الصوت مفخما.	ص– ض– ط– ظ
صوت منفتح	مرقق	Non-velarized	يكون تجويف الفم مع الصوت المنفتح أقل منه مع نظيره المطبق.	الأصوات غير المطبقة
المستعلي			ارتفاع اللسان إلى الحنك الأعلى، سواء أصاحبه إطباق أم لا.	خ– غ– ق– ص ض– ط– ظ
مستفل	منخفض		الاستفال ضد الاستعلاء، وهو انخفاض اللسان في الفم.	غير المستعلية
الصوت المتفشي		Hushing	صفة لصوت الشين، الذي يتم النطق به مع ارتفاع مقدم اللسان بصورة تسمح بحدوث احتكاك زائد (هشيش).	ش
المكرر	ترددي	Trill (Sonorant)	صفة لصوت الراء، الذي ينطق بطريقة يُحدث فيها طرف اللسان سلسلة من عمليات غلق لحظية، تتخللها عناصر حركية صغيرة.	ر (من أصوات الرنين)
خيشومي	أنفي	Nasal	تتصف الأصوات بهذه الصفة حين يغلق تجويف الفم، ويهبط الحنك الرخو، مع السماح بمرور الهواء عن طريق الأنف.	ن– م (من أصوات الرنين)
منحرف	جانبي	Lateral	يلتصق اللسان فيه مع الجزء الأوسط من أصول الأسنان، في حين تسمح حافتا اللسان الجانبيتان للهواء بالمرور إلى الخارج، وأحيانا يمر الهواء من جانب واحد فحسب.	ل (من أصوات الرنين)