

# A Rule-Based Algorithm for the Detection of Arud Meter in Classical Arabic Poetry

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**Abstract:** *Arud is the science of poems used in Arabic, Persian, Urdu, and other eastern languages. Determining the Arud meter of classical Arabic poems is a difficult and tiresome task for those who study poetry. In this paper, we focus on the computerized analysis of Arabic Arud meter. We introduce an algorithm that is able to determine the correct Arud meter for a given Arabic poem and is also able to convert the poem into Arud Writing. The algorithm is based on a set of well defined rules applied only on the first part (sadr صدر) of the poem verse. The algorithm consists of five main steps. The preliminary tests are quite satisfactory and the algorithm gave high accuracy. The algorithm can be used in systems that handle Arabic poetry such as information retrieval systems or teaching Arabic poetry for students.*

**Keywords:** *Arud meter algorithm, arabic poetry, arabic linguistic, arabic retrieval.*

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## 1. Introduction

Poetry and poet in pre-Islamic era has an important position in society. *Sha'ir* or poet plays an important role because it represented an individual tribe's prestige and importance in the Arabian Peninsula. Mock battles between poets from different tribes can take place instead of real wars or sometimes their poetry can be a reason for real battles. Most of that poetry wasn't preserved, what remains to these days is the finest of Arabic poetry. Pre-Islamic poetry is major source of grammar and vocabulary of classical Arabic language in addition to its eloquence and artistic value.

Souk-Ukaz was a festival to a regular poetry where the craft of the sha'irs would be exhibited. Within this festival, poet or rawi -reciter- used to say the newest poetry they heard or compose. The very best of these early poems were collected in the 8th century as the Mu'allaqat (pre- Islamic odes) because they hung them on the "Kaaba". The most famous poets of the pre-Islamic era are Imru' al-Qais, Samaw'al ibn 'Adiya, Other poets known as *su'luk* such as Ta'abbata Sharran.

Several characteristics distinguish the pre-Islamic poetry from the poetry of later times. In pre-Islamic poems characterized by strong vocabulary and short ideas. Also, other characteristic is the romantic or nostalgic prelude with which pre-Islamic poems would often start. There are many poetic themes such as: Madih, Hija, Ritha, Wasf, Ghazal and many others [6].

Modern poetry, on the other hand, deviated from classical poetry in its content, style, structure, rhyme and topics. Modern poetry is often connected with free verse, as is the case also in pre-Islamic poetry.

In this paper, a classical Arabic poetry Buhūr recognition method has been proposed. The method

utilizes the first part (*sadr* صدر) of the verse (*bayt* / بيت) writing styles and characteristics to identify the type of *Buhūr* that represents the verse. The proposed method consists of five main steps. These steps covert the input poetry into Arud Writing "الكتابة العروضية" in order to find the correct suitable meter (weight) that represents it.

The paper is organized as follows. In section 2, a general overview of Arabic Poetry Meter is given. As for section 3, the related works are briefly discussed. Section 4 discusses the methodology used to identify and recognize the poem Buhur. In section 5, we discuss the experimentation including the used dataset and results. Section 6 presents conclusions and future work plans.

## 2. Arabic Poetry Meter

Arabic poetry can be classified into two main types, rhymed or measured, and prose, with the former greatly preceding the latter. The founder of rhymed is Al-Khalīl ibn Ahmad Al-Farahidi (AD 718-786), which is also called Arud. Arud is the meter used in classical Arabic [19, 26, 27], and other eastern languages [4, 7, 16, 23]. Arabs call Arud as the science of poems ('ilm u shir). It originated from classical Arab poetry. Many nations later adapted it to their own poetry in the east. Arud is also related to 'iqa and usul in music in eastern cultures [5, 22, 28, 30]. Al-Farahidi wrote 15 verse types or meters for the first time [29] and later his student Al-Akhfash, added the 16th meter later. The meters of the rhythmical poetry are known in Arabic as "seas" (بحور / *Buhūr*). The measuring unit of seas is known as Arabic Patterns (" *Tafā'il* " (تفعيلة)), and every sea contains a certain number of *tafilat* which the poet has to observe in every verse (بيت /

*bayt*) of the poem. There are eight original Tafā'il (Mafā'ilun مفاعيلن, Fa'ilun فَعُولُن, Mufā'alatun مُفَاعَلَاتُن, Mafā'ilun مفاعيلن, Fā'ilātun فاعلاتن, Mustaf'ilun مُسْتَفْعِلُن, Fā'ilun فاعِلُن, Mfū'alat مفعولات).

A line of poetry, known as a *bayt*, is composed of two verse-halves: the first part (beginning) is called the *Sadr* (صدر literally Chest) and the other part is called the 'Ajuz (عجز literally belly). They are called by these terms because they represent the first part and the second part of a *bayt*. The measuring procedure of a poem is very rigorous. Sometimes adding or removing a consonant or a vowel can shift the *bayt* from one meter to another. Also, in rhymed poetry, every *bayt* has to end with the same rhyme (قافية / *qāfiyah*) throughout the poem [1]. Each of the *Buhūr* have a key written by Shafī Al-Deen Al heli (born and live in *Hela* in Iraq 1276 to 1349). Table 1 shows the sixteen meters with their Tafā'il and keys.

We have to say that these forms are the standard forms but for some reasons (will be explained in section 4) most of the *Buhūr* can have other forms due to changes in one of the their original Tafā'il.

Our work in this paper will handle a complete verse (*bayt* / بيت) that has all its Tafā'il. In cases where one or more Tafā'il are omitted from the verse then the verse is known as (مجزوء او منهك).

Table 1. Forms of the arabic meters with their tafā'il and Keys.

no.	Meter Name	Meter Pattern (Tafā'il)	Meter Key
1	Hazaj (هزج)	Mafā'ilun Mafā'ilun (مفاعيلن مفاعيلن)	على الأراج تسهيل مفاعيلن مفاعيلن
2	Wāfir (وافر)	Mufā'alatun Mufā'alatun Fa'ilun (مفاعلاتن مفاعلاتن فَعُولُن)	بحور الشعر وافر ما جميل مفاعلاتن مفاعلاتن فَعُولُن
3	Muḍā'iri' (مضارع)	Mafā'ilun Fā'ilātun (مفاعيلن فاعلاتن)	تعد المضارع مفاعيلن فاعلاتن
4	Tawīl (طويل)	Fa'ilun Mafā'ilun Fa'ilun Mafā'ilun (فَعُولُن مفاعيلن فَعُولُن مفاعيلن)	طويل له دون البحور فضائل فَعُولُن مفاعيلن فَعُولُن مفاعيلن
5	Mutaqārib (متقارب)	Fa'ilun Fa'ilun Fa'ilun Fa'ilun (فَعُولُن فَعُولُن فَعُولُن فَعُولُن)	عن المتقارب قال الخليل فَعُولُن فَعُولُن فَعُولُن فَعُولُن
6	Ramal (رمل)	Fā'ilātun Fā'ilātun Fā'ilun (فاعلاتن فاعلاتن فاعِلُن)	رمل الأبحر ترويه اللغات فاعلاتن فاعلاتن فاعلاتن
7	Khafif (خفيف)	Fā'ilātun Mustaf'ilun Fā'ilātun (فاعلاتن مُسْتَفْعِلُن فاعلاتن)	يا خفيفا خفت به الحركات فاعلاتن مستتعيلن فاعلاتن
8	Mujtathth (مجثث)	Mustaf'ilun Fā'ilātun (مُسْتَفْعِلُن فاعلاتن)	إن جثت الحركات مستتعيلن فاعلاتن
9	Madīd (مديد)	Fā'ilātun Fā'ilun Fā'ilātun (فاعلاتن فاعِلُن فاعلاتن)	لمديد الشعر عندي صفات فاعلاتن فاعِلُن فاعلاتن
10	Rajaz (رجز)	Mustaf'ilun Mustaf'ilun Mustaf'ilun (مُسْتَفْعِلُن مُسْتَفْعِلُن مُسْتَفْعِلُن)	في البحر الأراج بحر يسهل مستتعيلن مستتعيلن مستتعيلن
11	Sarī' (سريع)	Mustaf'ilun Mustaf'ilun Fā'ilun (مُسْتَفْعِلُن مُسْتَفْعِلُن فاعِلُن)	بحر سريع ما له ساحل مستتعيلن مستتعيلن فاعِلُن
12	Kāmil (كامل)	Mutaḍā'ibun Mutaḍā'ibun Mutaḍā'ibun (مُتَعَادِلُن مُتَعَادِلُن مُتَعَادِلُن)	كامل الجمال من البحور الكامل متفاعِلُن متفاعِلُن متفاعِلُن
13	Munsarih (منسرح)	Tafā'il: Mustaf'ilun Fā'ilat Mufā'ilatun (مُسْتَفْعِلُن فاعلاتن مُفَاعِلَاتُن)	منسرح فيه يضرب المثل مستتعيلن مفعولات متعيلن
14	Muḥāḍabb (مقضب)	Fā'ilatun Mufā'ilatun (فاعلاتن مُفَاعِلَاتُن)	اقتضب كما سألوا فاعلاتن متعيلن
15	Basīṭ (بسيط)	Mustaf'ilun Fā'ilun Mustaf'ilun Fā'ilun (مُسْتَفْعِلُن فاعِلُن مُسْتَفْعِلُن فاعِلُن)	إن البسيط لديه ببسط الأمل مستتعيلن فاعِلُن مستتعيلن فاعِلُن
16	Mutadārik (متدارك)	Fa'ilun Fa'ilun Fa'ilun Fa'ilun (فَعُولُن فَعُولُن فَعُولُن فَعُولُن)	حركات المحدث تتعيل فاعِلُن فاعِلُن فاعِلُن فاعِلُن

### 3. Related Work

Morphology is the study of the internal structure of words. In other words, morphology is simply the branch of linguistics that studies patterns of word-formation taken in their different uses and constructions [24]. Arabic Morphology is very complex and especially when it comes to poetry. It is true that research on processing of poetry meters in general and Arabic poetry meters in specific dates back to the 19<sup>th</sup> century [3, 4, 17, 19, 28]. However, most of the works done before are of theoretical goals that have appeared in the past, notably Chapter 3 of [7, 9, 10, 11, 12, 15, 20, 21]. These were all of article size and none of them dealt with more than a few poetic traditions as reported by [6].

There are few non-theoretical research of developing algorithms and systems for the determination of Arabic poetry meters (*Buhūr*) that can be found in the literature. One of these is the expert system developed by [14] called Expert System Harmony Test (ESHT). Their system determines the *bahr* for an input poem after checking firstly the correctness of the input poem harmony. The system will then convert the poem into Arud form. In case the poem harmony is incorrect, the system will highlight the incorrect positions. The proposed system makes decisions based on automated reasoning, and contains three modules:

- Editor: is the module that handle the interaction between the system and the user. It includes functions such as entering new poem.
- Knowledge base: is the module concerned with converting the Arabic poetry to Arud form using heuristic rules, and then it will convert it into a binary form by representing the vowel by "1" and the consonant by "0" using some rules.
- Consultation: is the module responsible to find out the *bahr* that match the input poem.

Test data of 20 poems were used to test the accuracy of the system. All 20 poems were guessed correctly. However, not many details of the test data and the rules used are found.

Another system is the one developed by [25] called "Computing System for Analyzing Arabic Poems Meter". Their system will try to find the Arabic poem meter name through two main steps: The first step will use Arud rules to analyze the verse and define long and short sounds. The second step: a comparison is carried out between the generated string of the short and long sounds and the rhythms of each meter one by one with the rhythms of verses that are needed to check. Their algorithm will find the correct Arabic meter name provided it firstly manages to find the correct rhyme for this verse. Their research explained only the algorithm in general without any information about the implementation or the experiment results.

The latest is a program developed by [2]. The program uses regular expression and Context Free Grammar (CFG) to help the user find the meter name for a given Arabic poem. This program implementation works using 3 phases where each phase prepares the input to the next phase. The three phases are:

- First phase: is to convert the input poetry from its standard form to Arud form,
- Second phase: is segmentation phase.
- Third phase: is where the detection of the poem meter name is achieved.

The data set used to evaluate their program consists of 128 verses from different Arabic poems. The program managed to find 96 (75%) correct meter name. And there were 32 (25%) verses that the program could not find the correct meter name [2].

#### 4. Meter Proposed Algorithm

To define the meter correctly there are five main steps we have to follow. These steps are summarized as follows:

- *Step 1.* Write the poem poetry part with *harakat* (حركات), otherwise it will be very hard to move to the next step.
- *Step 2.* Rewrite according to a rule says “what we pronounce is what we write and what we do not pronounce we do not write”. This is known as *Arud Writing* (الكتابة العروضية). Here we have many rules to apply and according to these rules we have to add or remove some letters. We will specify these rules later (Tables 2, 3, 4, 5). According to our algorithm no need to rewrite the whole *bayt* and we only need to rewrite the first part (*sadr* صدر).
- *Step 3.* Cut each line in a poetry into parts according to some rules - short and long syllable - “التقطيع العروضي” depending on the rules in previous step and then “الترميز العروضي” write it by using “—” and “\_” as shown in Table 6.
- *Step 4.* Define the suitable pattern (*Tafā'il* تقعيلة).
- *Step 5.* Choose the suitable meter (weight).

Step two is the most important step and will be discussed in details later. Table 2 shows cases of words that have to be changed. Sometimes we have to add some letters according to the Harakat on some letters. Table 3 shows cases of added letters. On the other hand, we have to remove some letters in some cases. Table 4 shows cases we have to remove a letter. From Table 5 we have to differentiate between (Alef Lam ال القمرية) and (Alef Lam ال شمسية). Table 6 is related to step three of Meter Proposed Algorithm mentioned before which show the “الترميز العروضي” for each *Bahūr*. We order them according to the number of characters in each sequence; we will use this size to help us in getting the *Bahūr* name fast. This table depends on the original form of *Tafā'il*.

Table 2. Examples of words that has to be changed.

Case No.	Case	Changes	Example
1.	Word in the set (هذا، هذه، هذان، هذين، هؤلاء، ذلك، تلكم، ذلكما)	Add a letter (Alef 'ا) with sukoon (◌ْ) over it after the first letter	هذا became هذا ذلك became ذلك
2.	Word in the set (الله، الرحمن، اله)	Add a letter (Alef 'ا) with sukoon (◌ْ) over it before the last letter	الرحمن became الرحمن
3.	word in the set (طاوس، داود)	Add a letter (Waw و) with sukoon (◌ْ) over it after the letter (Waw و)	طاوس became طاوس طاوس became طاوس
4.	the word is (طه)	Add a letter (Alef 'ا) with sukoon (◌ْ) over it after the first and last letter	طه became طها
5.	the word (لكن) with sukoon (◌ْ) over the last letter	Add a letter (Alef 'ا) with sukoon (◌ْ) over it after the first letter	لكن became لكن
6.	the word (الآنك)	convert it to (الآنك)	
7.	The words مائة، أنا	Delete the (Alef 'ا)	مائة became مائة أنا became أنا
8.	The words أولو، أولات	Delete the (Waw و)	أولو became ألو أولات became آلات
9.	These words if (◌ْ) came after them. (إذا، لئذا، هذا، كذا، إنا، ما، إنما، حاشا، خلا، عدا، كلا، لما)	Delete the (Alef 'ا)	

Table 3. Letters to be added.

Case No.	Case	Changes	Example
1.	letter is (hazet mad ا)	Convert it to (ا)	قرآن is converted to قرآن
2.	letter has a (shadah ◌ْ and a short vowel) AND the word is the last word	If the short vowel is (◌ْ) then convert (◌ْ) to (◌ْ) and add (Waw و). If the short vowel is (◌ْ) then convert (◌ْ) to (◌ْ) and add (Alef 'ا). If the short vowel is (◌ْ) then convert (◌ْ) to (◌ْ) and add (Yaa ي)	شُدْ converted to شُدْ
3.	If the letter has a (shadah ◌ْ)	Duplicate the letter with (◌ْ) over first and (Fatha ◌َ)	سُرْ converted to سُرْ
4.	the letter has (Tnween ◌◌ or ◌◌ or ◌◌) over it then	Convert Tnween to a suitable short vowels and add a letter (Noon ن) with (◌ْ) over it	عَلْمُنْ convert to عَلْمْ
5.	the word start with (Alef همزة وصل) AND exceeded by (Waw و، Fa'a ف)	Delete letter (Alef 'ا) otherwise add (◌ْ) over (Alef 'ا)	وافهم converted to وافهم Or افهم converted to افهم
6.	the last letter is (Ha'a ضمير الغائب المنكر) with short vowels	Convert short vowels to long vowels at the end of word with (◌ْ) over it	لَهُ converted to لَهُ بِهِ converted to بِهِ
7.	The last letter is (Meem الجمع) with a letter (Ha'a هـ or Kaf ك) before it	Convert short vowels to long vowels at the end of word with (◌ْ) over it.	لَكُمْ converted to لَكُمْ عِنْدَهُمْ converted to عِنْدَهُمْ
8.	the last letter is (Kaf ك) كاف المخاطب منكر ومؤنث with short vowels) AND the word is the last word	Convert short vowels to long vowels at the end of the word with (◌ْ) over	كَتَابِكَ converted to كِتَابِكَ كَلَامِكَ converted to كِلَامِكَ
9.	the last two letters are (long vowels and Noon ن) AND the word is the last word	Add a letter (Alef 'ا) at the end of the word with (◌ْ) over it.	يُسَلِّمَانْ converted to يُسَلِّمَانَا يُسَلِّمُونَ converted to يُسَلِّمُونَا
10.	the last letter is (Taa ت) with short vowels) AND the word is the last word	Convert short vowels to suitable long vowels at the end of the word with (◌ْ) over it.	قُلْتَا convert to قُلْتَا قُلْتِ convert to قُلْتِ قُلْتِي convert to قُلْتِي

Table 4. Letters to be deleted.

Case No.	Case	Changes	Example
1.	The word start with (Alef همزة وصل) AND exceeded by (Waw و or Fa'a ف)	Delete (Alef 'ا)	وَأَفْهَمَ to وَأَفْهَمَ
2.	The word start with (Alef Lam القمرية ال)	Delete (Alef 'ا) and keep (Lam ل) with ( ؤ ) over it.	وَالْقَمَرِ to وَالْقَمَرِ
3.	The word start with (Alef Lam الشمسية ال)	Delete (Alef Lam ال) and duplicate the letter after it	وَالصَّنْقِ to وَصَنَّصِقِ
4.	The word (verb, noun or letter) ends with long vowels and the word after start with ( ؤ )	Convert the long vowels to short vowel.	أَتَى الْمَظْلُومِ to أَيْتِ الْمَظْلُومِ
5.	The word end with (Waw Alef وا) in all types of verbs	Delete the (Alef 'ا).	رَجَعُوا to رَجَعُو

Table 5. Alef Lam القمرية ال and Alef Lam الشمسية ال letters.

Alef Lam القمرية ال		Alef Lam الشمسية ال	
ا، ب، ج، ح، خ، ع، غ، ف، ق، ك، م، و، هـ، ي		ا، ب، ج، ز، س، ش، ض، ط، ظ، ل، ن	
وا + ال القمرية	e.g.: Remove the وا +	وا + ال الشمسية	e.g.: Remove the وا +
Remove the وا +	رَفَعُوا الْعِلْمَ converted	Remove the وا +	رَفَعُوا السَّارِيَةَ converted

Table 6. Arabic bahūr syllables. الترميز العروضي.

Bahūr Name	الترميز العروضي	Size (number of character)
Hazaj (هزج)	— — — — —	8
Muḏāri' (مضارع)	— — — — —	8
Mujtathth (مجتث)	— — — — —	8
Muqtaḏabb (مقتضب)	— — — — —	8
Madīd (مديد)	— — — — —	11
Munsarih (مفسرَح)	— — — — —	11
Sarī (سريع)	— — — — —	11
Mutaqārib (مقارب)	— — — — —	12
Mutadārik (متدارك)	— — — — —	12
Ramal (رمل)	— — — — —	12
Khafif (خفيف)	— — — — —	12
Rajaz (رجز)	— — — — —	12
Wāfir (وافر)	— — — — —	13
Basīṭ (بسيط)	— — — — —	14
Ṭawīl (طويل)	— — — — —	14
Kāmil (كامل)	— — — — —	15

Table 6 depends on the standard forms of the Buhūr so the Tafā'il is in its original form, but for some reasons each Tafā'il may change its form as shown in Tables 7 and 8. According to these changes, we have to expect that all.

واحفظ لسانك واحترز من لفظه فالمرء يسلم باللسان ويُعطب			
حشو Changes here called (علا،)	حشوا Changes here called (رحاف)	عروض Changes here called (علل)	حشو Changes here called
العجز		الصدر	

Figure 1. Rhyme parts and changes in Tafā'il.

The Buhūr have other forms. Figure 1 shows the parts of rhyme and type of changes in Tafā'il.

We will talk about Al Kāmil meter (كامل) as an example. Al Kāmil (كامل) has the following Tafā'il: Mutafā'ilun Mutafā'ilun Mutafā'ilun ( مُتَفَاعِلُنْ )

(مُتَفَاعِلُنْ مُتَفَاعِلُنْ) which means that it has only one Tafā'il repeated three times. Each occurrence of this Tafā'il according to Table 7 may have the other form and depending on probability we may have eight different forms as in Table 8 where (مُتَفَاعِلُنْ) can be represented as — — — — — and (مُتَفَاعِلُنْ) can be represented as — — — — — and changes in (عروض) is the same as (حشو).

Table 7. Original Tafā'il and other forms.

Original Tafā'il	Other forms
فَعولُنْ	فَعولُنْ
مَفَاعِلُنْ	مَفَاعِلُنْ
فَاعِلَاتُنْ	فَاعِلَاتُنْ
فَاعِلُنْ	فَاعِلَانْ or فَعِلَانْ
مُسْتَفَعِلُنْ	مُتَعَلِنْ or مُسْتَعَلِنْ or مُتَعَلِنْ
مُتَفَاعِلُنْ	مُتَفَاعِلُنْ
مَفَاعِلَاتُنْ	مَفَاعِلَاتُنْ
مَفْعولات	مَفْعولات

Table 8. Different format of Al Kāmil (كامل) meter.

Tafā'il	الترميز العروضي	size
Mutafā'ilun Mutafā'ilun Mutafā'ilun مُتَفَاعِلُنْ مُتَفَاعِلُنْ مُتَفَاعِلُنْ	— — — — — — — — — — — — — — —	15
Mufā'ilun Mutafā'ilun Mutafā'ilun مُتَفَاعِلُنْ مُتَفَاعِلُنْ مُتَفَاعِلُنْ	— — — — — — — — — — — — — — —	14
Mutafā'ilun Mufā'ilun Mutafā'ilun مُتَفَاعِلُنْ مُتَفَاعِلُنْ مُتَفَاعِلُنْ	— — — — — — — — — — — — — — —	14
Mutafā'ilun Mutafā'ilun Mufā'ilun مُتَفَاعِلُنْ مُتَفَاعِلُنْ مُتَفَاعِلُنْ	— — — — — — — — — — — — — — —	14
Mufā'ilun Mufā'ilun Mutafā'ilun مُتَفَاعِلُنْ مُتَفَاعِلُنْ مُتَفَاعِلُنْ	— — — — — — — — — — — — — — —	13
Mufā'ilun Mutafā'ilun Mufā'ilun مُتَفَاعِلُنْ مُتَفَاعِلُنْ مُتَفَاعِلُنْ	— — — — — — — — — — — — — — —	13
Mutafā'ilun Mufā'ilun Mufā'ilun مُتَفَاعِلُنْ مُتَفَاعِلُنْ مُتَفَاعِلُنْ	— — — — — — — — — — — — — — —	13
Mufā'ilun Mufā'ilun Mufā'ilun مُتَفَاعِلُنْ مُتَفَاعِلُنْ مُتَفَاعِلُنْ	— — — — — — — — — — — — — — —	12

Table 9 shows other Tafā'il in Arud (عروض), this means that forms of (علل).

Table 9. Forms of (علل) in Arud Tafā'il.

Tafā'il	Forms	الترميز العروضي
Mutafā'ilun مُتَفَاعِلُنْ	Mufā'ilun مُتَفَاعِلُنْ	— — — — —
	Mufā'il مُتَفَاعِلُنْ	— — — — —
	Mufā' مُتَفَاعِلُنْ	— — — — —
	Mutafā' مُتَفَاعِلُنْ	— — — — —

The algorithm for finding the meter of a poem is Arud Function as Follows. The algorithm accepts a single verse and outputs the specific meter of the verse.

Algorithm 1: The Arud Writing

Input: Bayt (Verse)

Output: The meter of the Bayt

Method:

1. Write the (Bayt) with all of its harakat and Hazah ( ~ , ء )..
2. Get the first half of the Bayt (Sadr).

3. Write the words of bayt (Sadr) in Arud Writing ( ) ( الكتابة العروضية).
4. Convert the Sadr Arud Writing to syllables( " الترميز العروضي" by using " — " and " \_ "
5. Find Size which equal to Number of sequence of (—) and ( \_ )
6. Check the Size depending on Size in Table 6 and then Match sequence of (—) and ( \_ ) of the Sadr with equivalent one in the table
7. Print the name of Bahūr found in the match in 6

Algorithm 1 takes the first half of the Bayt (Sadr) and writes it in Arud Writing using the Arud Function. This writing is done according to the rules found in Tables 2, 3, 4, and 5 and the function is as follows:

Algorithm 2: Arud Syllables

Input: the Bayt Sadr

Output: the Bayt Sadr is converted into Arud Writing ( الكتابة العروضية).

Method:

1. For each word in the Bayt Sadr
  - a. If the word is found in Table 2 words Then Convert it.
  - b. Get the first letter from the current word and for each letter of the word
    - i. Match the case of letter according to Table 3, Tables 4 and 5.

2. End

Algorithm 2 will then takes the Arud writing of the Bayt Sadr and convert into its equivalent Arud syllables using the ArudSyllables Function as follows:

Algorithm 3: Meter syllables

Input: the Bayt Sadr Arud Writing

Output: the Bayt Sadr is converted into Arud syllables

Method:

1. While there are more than one letter of the Bayt Sadr Arud Writing
  - a. Get the two neighbors.
  - b. if they are ( متحرك وساكن )
    - i. write ( — )
    - ii. Skip both of them
  - c. Else if they are ( متحرك ومتحرك )
    - i. Write ( \_ )
    - ii. Skip the right most letter and keep other one

2. End

After finding the syllables, algorithm 3 will search for the meter syllables that match these syllables according to size of syllables. The algorithm will then print the Meter name found.

The following example shows how this algorithm can be applied to find the meter. Suppose we have the following rhyme:

أَسَدٌ قَرَأَيْسُهَا الْأَسْوَدُ يَقْدُهَا      أَسَدٌ تَصِيرُ لَهُ الْأَسْوَدُ نَعَالِيَا

According to the algorithm, take only the Sadr (صدر literally Chest) [أَسَدٌ قَرَأَيْسُهَا الْأَسْوَدُ يَقْدُهَا]

Table 10. Example1 of the proposed algorithm.

أ	س	ن	ف	ز	ا	ي	س	ن	هـ	أ	س	ن	ف	ز	ا	ي	س	ن	هـ	أ
									Case 2 table 3										Case 4 table 2	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

After converting to Arud Syllables (الترميز العروضي) as shown in Table 10 and then comparing the result with the data in Table 6 we find that it belongs to Kāmil (كامل).

Example 2 is:

صَبْرًا عَلَى شِدَّةِ الْأَيَّامِ إِنَّ لَهَا عُقْبَى وَمَا الصَّبْرُ إِلَّا عِنْدَ ذِي الْحَسَبِ

Taking the Sadr (صدر literally Chest) [ صَبْرًا عَلَى شِدَّةِ ] الأأيام إن لها

Table 11. Example 2 of the proposed algorithm.

ص	ب	ر	ن	ع	ل	ش	د	ت	ل	أ	ي	م	ن	ل	هـ
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

After converting to Arud Syllables (الترميز العروضي) as shown in Table 11 and then comparing the result with the data in Table 11 we find that it belongs to Basīt (بسيط).

### 5. Analysis and Results

In this paper we try to define a new algorithm to find the Arabic poem meter by analyzing the Sadr (صدر literally Chest) only. We applied this algorithm on 417 different rhymes from different Arabic poems and got the results shown in Table 14.

Table 14. The proposed algorithm test results.

Total number of rhyme	Correct meter	Wrong meter
417	343	74
Percentage	82.2%	17.8%

Also there are some rules applied more than others. e.g., in all rhymes analyzed we found that: case 3 and 4 in Table 4 found in 97%, case 3 in Table 3 found in 89%, whereas case 4 in Table 2 are found in 82%.

The wrong result obtained by the proposed algorithm came from one of the following cases:

- Case 1: the different forms of Tafā'īl as shown in Table 7- which is only for one Bahūr-. Because of that sometimes we found two meter for the same rhyme. The following example shown in Table 15 explains this:

أَمْ نَاطِرٌ يَهْدِي الْمَنَابِيَا طَرْفُهُ      حَتَّى كَانَّ الْمَوْءَ مِنْهُ فِي النَّظَرِ  
 أَمْ نَاطِرٌ يَهْدِي      [ صَدْرًا لِيَتَّخِذَ ]

Table 15. An example of a wrong result by the proposed algorithm.

أ	م	ن	ظ	ر	ن	ي	هـ	د	م	ن	ا	ط	ف	هـ
								Case 2 Table 3						Case 5 Table
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

According to Table 6 this is Rajaz (رجز) meter and in the same time from Table 8 it is Kāmil (كامل) in its

other forms. So if we have a poem and want to find its meter we must analyze many rhymes to find the right meter.

- **Case 2:** we have to be sure that the (حركات) of the rhyme found; otherwise its conversion to *Arud Syllables* (الترميز العروضي) will be wrong. E.g.; suppose we have the following

ضيف ألم إليك لم تحفل به      فترى له أسفا ودمعا يسكب

The first word (ضيف) can be (ضَيْفٌ) - the last character may take any short vowels - so it can be represented as (— َ), or the word can be (ضَيْفٌ) converted to (ضَيْفٌ) which can be represented as (— —).

## 6. Conclusions

There are few well designated algorithms for detecting the meter of Classical Arabic poem. Those algorithms as explained in the literature are either complicated and use database or/and not well defined and tested. The proposed algorithm presented above computes the correct meter of verses with high accuracy (82%).

This algorithm is implemented to find classical Arabic poetry meter (*Buhūr*). It utilizes the complete verse (بيت / *bayt*) writing styles and characteristics to identify the type of meter that represents the verse. The proposed algorithm consists of five main steps which convert the input poetry into *Arud Writing* in order to find the correct suitable meter that represents the verse. It is based on a set of well defined rules used through the algorithm steps. The most important part of the algorithm is the *Arud Writing* part. Here we have many rules to apply and according to these rules we have to add or remove different letters. The algorithm only needs to rewrite the first part (*sadr* صدر) of the poem verse and not the whole *verse*.

The algorithm was tested with a set of verses from different classical Arabic poems and we tried to choose poems that cover all meters types. The results showed a high level of accuracy with 82% of the verses were correctly matched the algorithm recognized meters.

The majority of incorrect results are caused by the similarity of different meters weights (*Tafā'il*) as explained in Table 15. The algorithm can be further improved for even higher accuracy. Further studies and improvement can be carried out to include more rules in the algorithm. This algorithm can also be used in different applications such as Arabic retrieval system that retrieves poems according to their meter or systems used for teaching Arabic poetry for students. In future work, we plan to generate the *Harakat* automatically.

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