

Learning Meters of Arabic and English poems

With Recurrent Neural Networks

Prof. Waleed A. YOUSEF

The Team

June 19, 2018

Computer Science department

Faulty of Computers and Information, Helwan University

Table of contents

1. Introduction
2. Literature Review
3. Datasets
4. Methodology
5. Results

Introduction

فَقُولُ رَسُولِ اللَّهِ أَزْكَى وَأَشْرَحُ

وَدَعْ عَنْكَ آرَاءَ الرِّجَالِ وَقَوْلَهُمْ

But ... What is poetry?

General Definition:

- **Poetry** is a piece of writing or speaking, which **MUST** follow specific Patterns.

Example, *English verse*:

That **time** of **year** thou **mayst** in **me** behold

To detect poems' meters, we need to learn those **Patterns**.

ودع عنك آراء الرجال وقولهم
فقول رسول الله أذكى وأشرح

- A **poem** is a collection of verses.
- **Vowels** carry one of َ ُ ِ.
- **Consonants** carry ْ.
- A **foot** التفعيلة: is an ordered sequence of vowels and consonants.

Feet	Scansion
فَعُولُنْ	0/0//
فَاعِلُنْ	0//0/
مُسْتَفْعِلُنْ	0//0/0/
مَفَاعِيلُنْ	0/0/0//
مَفْعُولَات	0//0///
فَاعِلَاتُنْ	0/0//0/
مُفَاعَلَتُنْ	0///0//
مُتَفَاعِلُنْ	0//0///

- **Meter** البحر: is a ordered sequence of **feet**.

ويَسْأَلُ فِي الْحَوَادِثِ ذُو صَوَابٍ
 وَيَسْأَلُ فُلَ حَوَادِثِ ذُو صَوَابِينَ
 0/0// 0///0// 0///0//
 فَعُولُنْ مَفَاعِلَتُنْ مَفَاعِلَتُنْ

Meter Name	Meter feet combination
<i>al-Wafeer</i>	مَفَاعِلَتُنْ مَفَاعِلَتُنْ فَعُولُنْ
<i>al-Taweel</i>	فَعُولُنْ مَفَاعِلَتُنْ فَعُولُنْ مَفَاعِلَتُنْ
⋮	⋮
<i>al-Moktadib</i>	مَفْعُولَاتُ مُسْتَفْعِلُنْ مُسْتَفْعِلُنْ
<i>al-Modar'e</i>	مَفَاعِلَتُنْ فَاعِلَاتُنْ مَفَاعِلَتُنْ

English Prosody

English Meters Building Blocks:

- **Syllables:** $/\text{'w}\text{ɔ:}\text{t}\text{ə}/ = / \text{'w}\text{ɔ:}/ + / \text{t}\text{ə}(\text{r})/$.
 - **stressed** + unstressed.
- **Foot:** is a combination of stressed and unstressed syllables.

Feet	Stresses Combination
<i>Iamb</i>	$\times /$
<i>Trochee</i>	$/ \times$
<i>Dactyl</i>	$/ \times \times$
<i>Anapest</i>	$\times \times /$
<i>Pyrrhic</i>	$\times \times$
<i>Amphibrach</i>	\times / \times
<i>Spondee</i>	$//$

Meter: is repeating a foot n times; where $n \in [1, 8]$.

Iambic pentameter verse:

That **time** of **year** thou **mayst** in **me** be**hold**.
Iambic Foot 2nd 3rd 4th 5th

Literature Review

Abuata and Al-Omari:

- Five-step Algorithm
 1. Getting the input, carrying full diacritics.
 2. Metrical scansion rules are applied to the Arud writing. 0/0/..
 3. Grouping zero and ones to feet **تفعيلات**.
 4. A class is assigned to the input.
- **Results:** 82.2% of 417 verses.

Alnagdawi et al, similar approach; Context-Free Grammar; 75% correctly classed from 128.

ويسأل في الحوادث ذو صوابٍ
ويسأل فل حوادث ذو صوابين
0///0// 0///0// 0///0//
مفاعلتن مفاعلتن مفاعلتن

Issues;

- A huge constrain. **Diacritics** are a must.
- Converting the text into pronounced text is **probabilistic**.
 - اثبات الحروف المحذوفة خطأً
 - التصرف فى التقاء الساكنين

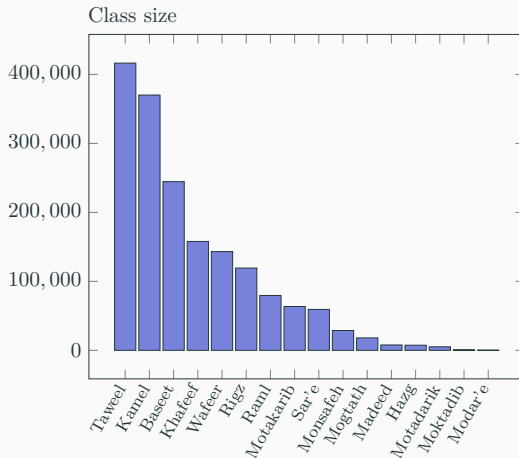
Metric or Free-Verse:

- Verses are represented as vectors of **statistical features**.
 - Average number of feet per line.
 - Longest run of a single foot.
 - Percentage of foot changes.
- He has used an stress-annotated dataset, which means that the pattern is already detected!

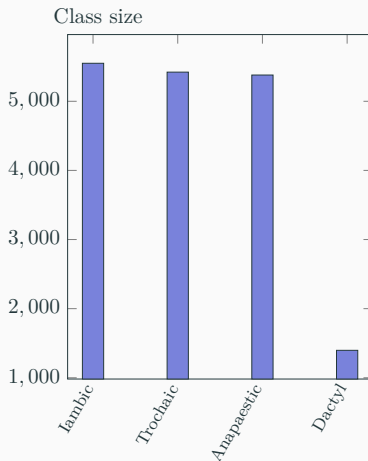
Our point of departure

Datasets

Arabic Dataset:



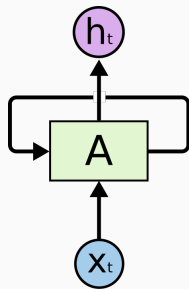
English Dataset:



Methodology

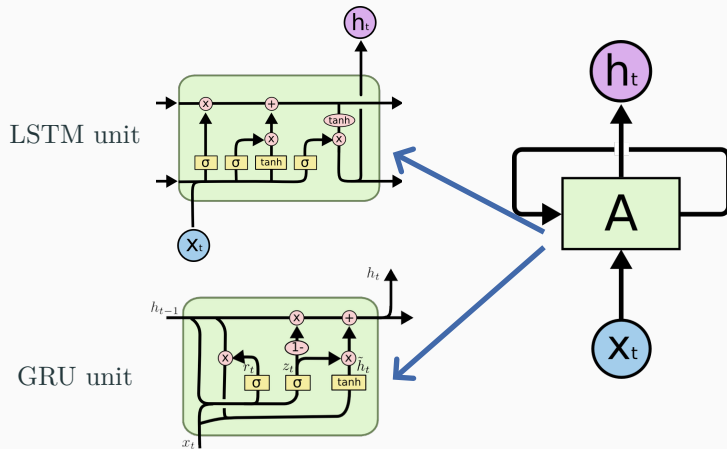
Which Network!

- **Pattern:** is a sequence of characters.
- Unlike feedforward neural networks, RNNs can use their internal state (memory) to process sequences of inputs.



Rolled Rnn unit

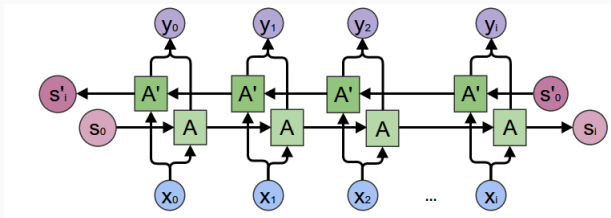
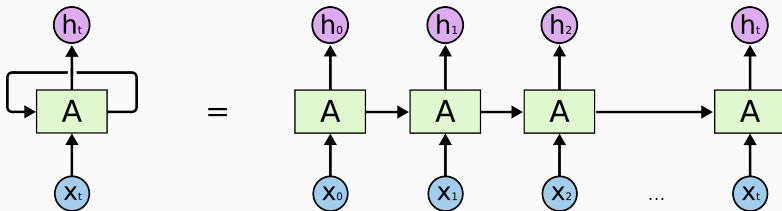
RNN, Architectures



- Two variants of unidirectional *recurrent units*.

RNN, Architectures

Unidirectional & Bidirectional RNN:



An Issue:

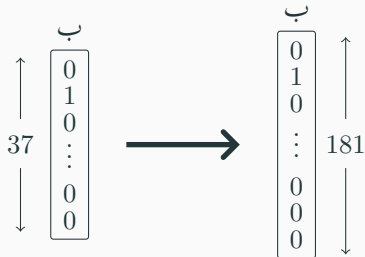
- Diacritics are standalone characters!
 - $\text{len مرحبا} \neq \text{len مَرَحَبًا}$
 - We have represented the letter and its diacritic as a **one character**.

Benefits:

1. Verse's length is fixed, regardless the diacritic states.
2. Saving more space, by shorten the length of full diacritic verses.
3. Models can be tested on both diacritic or non-diacritic data.

Encoding Techniques

1. One-Hot
2. Binary
3. Two-Hot (new technique)

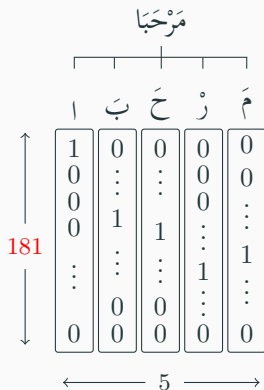


One-Hot Vector: from 37×1 to 181×1

181 is the number of all combination between letters and diacritics.

$$181 = 36 + 36 \times 4 + 1$$

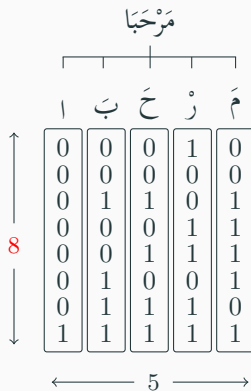
One-Hot, example



Binary

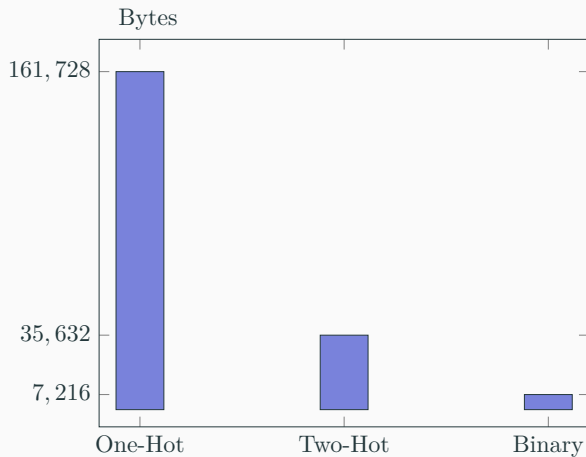
Let n be the vector length.

$$n = \lceil \log_2 l \rceil \quad l \in \{181, 28\}$$



$$\begin{array}{c}
 \updownarrow 37 \\
 \boxed{\begin{array}{c} \text{ح} \\ 0 \\ 1 \\ 0 \\ 0 \\ \vdots \\ 0 \end{array}} \\
 m
 \end{array}
 +
 \begin{array}{c}
 \text{و} \\
 \boxed{\begin{array}{c} 1 \\ 0 \\ 0 \\ 0 \end{array}} \\
 k
 \end{array}
 =
 \begin{array}{c}
 \updownarrow 41 \\
 \boxed{\begin{array}{c} \text{ح} \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ \vdots \\ 0 \end{array}} \\
 \left. \begin{array}{l} \text{ } \\ \text{ } \end{array} \right\} \begin{array}{l} 4 \times 1 \text{ diacritic vector} \\ \text{which represents } \text{و} \\ \text{ } \\ 37 \times 1 \text{ letter vector} \\ \text{which represents } \text{ح} \end{array}
 \end{array}$$

Space Comparison



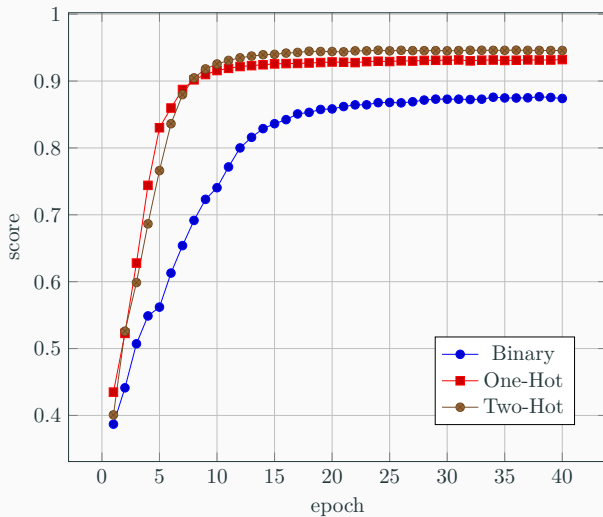
Results

Arabi Results

#	data size	encoding	diacritic	archit.	f1
1	full data	two-hot	Yes	7L, 50U, 0	95.79%
2	full data	two-hot	No	7L, 50U, 0	95.43%
3	full data	binary	Yes	7L, 81U, 0	95.51%
4	full data	binary	No	10L, 30U, 0	93.2%
5	full data	one-hot	Yes	7L, 50U, 1	95.32%
6	full data	one-hot	No	7L, 82U, 0	93.94%
7	eliminated	two-hot	Yes	7L, 81U, 1	95.88%
8	eliminated	two-hot	No	4L, 50U, 1	96.29%
9	eliminated	binary	Yes	7L, 81U, 1	94.87%
10	eliminated	binary	No	4L, 82U, 0	96.38%
11	eliminated	one-hot	Yes	7L, 75U, 0	95.65%
12	eliminated	one-hot	No	7L, 50U, 0	95.04%

id	encoding	cell type	f1 test
1	one-hot	GRU	81.35%
2	one-hot	LSTM	80.34%
3	binary	LSTM	75.43%
4	binary	GRU	75.04%

Encoding Effect



Binary Encoding Problem

ع	م
0	0
0	0
1	1
0	1
1	1
1	1
0	0
1	1

Questions?