Arabic Automatic Speech Recognition (Case of Minimal Syllable) AutomaticTreatment of Arabic Language (Case of Minimal Syllable)

M.A.Mohammed Dib
University of Mascara
Algeria

Abstract:

This paper aims at shedding light upon a very complex problem which concerns speech recognition with regard to Arabic language trying to account for some techniques of implementing Arabic in the field of artificial intelligence. This work hinges first and foremost on three technological tools; Gold wave ,Mat lab and Neural Net Works to treat automatically the minimal syllable located in first, mid, and final position of three Arabic words recorded by thirty speakers of different age and sex. Many experiments have been done in this work regarding the types of neural networks .The optimal neural net work is that of non- ordered data with one layer, five nodes and 150 steps because it has given an error rate of 0.0032

Introduction

It is becoming something ridiculous to ignore the importance of rapid changes resulting from globalization whose octopus hand tries to cover both of micro and macro fields and technological process in particular, therefore should accept and cope with these changes so as to serve Arabic language, its community, and to solve

problems such as communication between man and machine.

My paper is under the title of "***Automatic Treatment of Arabic language (Case of minimal syllable)***" and there is no doubt that the spurs behind this work are: The sharp deficiencies of the Arabic language as far as computer sciences are concerned, more simply put the problems that Arabic language is facing nowadays with regard to globalization which tries to put it back in the black despite its potential words, the number of its users and its system in terms of flexibility and exactness.

My present paper aims at shedding light upon a very complex problem which concerns speech recognition and remains ambiguous with regard to Arabic language. In this account I try to identify limitations that point the way to this research relying upon Neural Net Works as a means of recognition.

A brief sketch of the outline can show two parts; a theoretical side and practical one. The theoretical side deals with speech recognition, automatic speech recognition, intelligence, and neural net works. The practical side, however, contains syllable, types of syllables in Arabic, corpus, informants, syllable in question, automatic treatment, result and a conclusion.

Speech recognition

Speech recognition can be viewed as a communication problem between man and machine, that is, machine tries to recognize a word sequence pronounced by a speaker

whose speech production process is very complicated and goes through some stages; the brain first generates the text which is composed of word strings, then goes to the acoustic process where converted into audible wave form (Wu Chou Avaya, 2009:14). In other words an analog signal is converted into an acoustic signal or digital one to get classified decisions, or a variable stimulus is transformed into a constant response.(R.Plomp,2002:94)
Speech recognition is an inverse operation which starts from the speech wave form and ends in decoding a message. It is a mechanism able to decipher speech signal coming from the vocal tract or nasal cavity represented in a sequence of linguistic units found in the message that the speaker wants to transmit. (L. Rabiner &B. H. Juang, 2009:4)
The final goal of automatic speech recognition is communication between man and machine. The interaction has known many applications due to the rapid growth of devices and technological programmes (Antonio M. Peinado, 1995). Automatic speech recognition requires knowledge of many fields such as signal processing, acoustic phonetics, patterns recognition, communication, theory of information, physiology

Intelligence

No exact definition is found for the word intelligence, however some attempts were made to make the term more clear. It is the ability to understand and to think (Oxford dictionary, 2010). It is the ability learn, comprehend and to think (Longman advanced dictionary date). There are a lot of types of intelligence which can be summarized into

seven forms of knowledge; linguistic intelligence, mathematical and logical intelligence, spatial intelligence, musical intelligence, kinesthetic bodily intelligence, personal intelligence and interpersonal intelligence (H. Gardner, 1938).

As for artificial intelligence, it can be said that it is the reproduction of all types of intelligence using artificial means such as Neural Net Works. The goal of artificial intelligence is to simulate human intelligence. The idea came after having investigated tremendous fields such as medical field and noticed the work of the human body and the brain in particular, linguistic field and understood the process of language and therefore dealt with NLP (W.N. Dinedane, 1995:13). Moreover artificial intelligence tries to realize tasks similar of that used by human intelligence. It entails robot behaviour, language comprehension, patterns recognition, and knowledge representation. (The Hutchinson Encyclopedia)

Neural Net works

It is a challenge nowadays to understand the human brain's work. It is undoubtedly that the best way which can enable us to investigate data processing in the human brain mathematically and computationally is the modelisation of the NNW.

NNW can be defined as a mathematical system which contains processors similar to the brain's cells. They contain a set of nodes that gather input from different sources then send them to other nodes which in their turn resend them to other nodes. They can get very complex input and represent them in a very simple output. They contain three layers; input layer, output layer, and a hidden

layer in between where each processor is in contact with another one throughout synapses.(The Hutchinson Encycloedia,1999) They represent many mathematical models of human brain's functions such as: Comprehension, calculation and memorization.

There are many different types of NNW, however they have same four basic attributes which can be summarized as a set of processing units, a set of communication, a computing procedure, and a training procedure (J.Tebelskis, 1995).

Syllable

No definition is completely satisfactory for syllable, but any attempt at a definition should take into consideration that it is a prominence peak surrounded by a cluster of consonants, however sometimes syllable boundaries are put aside and the question whether some peaks such as / s/ in stop are not considered as syllables are to be avoided (San Duanmu,2008:36) . Another definition states that syllable is related to chest pulse but does not refer to syllable boundaries, more simply put Gimson notes that the double chest pulse does not seem clearly in the word *seeing* [**si:IN**]and the pulse theory cannot decide whether the word *beer* [**biÄ**] contains two syllables in American pronunciation. This question ship generates some doubts on whether syllables are linguistic units or not. Chomsky, Halle, Steriade, Gimson, Belvins do not consider them as phonological units.(Ibid) Despite all this syllable appears clearly in some cases for example people agree that the word Canada entails three syllables in

contrast the word America comprises four syllables.(Op cite)

Syllable in Arabic

Syllable in Arabic always starts with a consonant and ends either with a vowel and is called the open syllable or with a consonant and is called the close syllable. This means that the word in Arabic never starts with a consonant cluster, more simply put Arabic rejects the starting of three connected plosive consonants. The following example is a good demonstration of the point. (**uktub**) is the imperative form of the verb to write and is impossible to say (**ktub**) because the Arabic phonological system rejects consonant cluster, so we brought the ***hamza*** which stands for the vowel /u/ the same thing can be said for the Greek word (platoon) which has become Aflaton in Arabic and the French word franc which has changed into Ifrange (Henry Flesh,2007:43)

Generally speaking the syllable is an association between a consonant and a vowel. Roman Jacobson defines the syllable as a group of structure which encompasses two associated phonemes whose degree of aperture is different; one of a smaller degree and the other of a bigger one.(HacéneAbdelwahab,1984:27) Ampere Crambe, however, argues that speech hinges upon breathing, and air exhaling is similar to pulsation, each muscle contraction with the increase resulting from the air pressure forms a chest pulse, and each chest pulse in its turn forms a syllable. The pattern of chest pulses is the basis of human language. (Mubarak,Hanun:65)Some sources said that the dividing speech into syllables goes back to a long time with regard to Arabs and goes back to the period where Arabic language was an oral language and relied only on the

listening process to transfer literature and arts. Aljahid one of the Arab grammarians used the term syllabification which means segmentation of speech. He said that the sound is a device of speech whose role is syllabification and connection (Aljahid:79)

Connected speech encompasses syllables that bear the phonotactic of a particular language. It has been mentioned earlier that syllables may be divided into open and closed ones. Open syllables are those which end with short or long vowel, but closed syllable are those which end with a consonant with an absence of mark referred to as sukun. The tri lateral root verb (fataha) contains three open syllables, yet the noun (fathun) comprises two closed syllables: /fat/ and/ hun/. (I. Annis,1971 :162)

Structure of Arabic syllable:

Syllable is a combination of a consonant and a vowel which goes on a par with the system of each language in forming its syllable structure and relies upon the respiratory rhythm. The minimal syllable in Arabic is formed from one consonant followed by a short or a long vowel; this means that a sequence of two consecutive consonants is unacceptable except in case of pause.

The syllable in Arabic never starts with two consonants or a vowel, this is why syllables in all languages consist of vowels as centers preceded or followed by consonants in spite of the differences that exist between languages over the location of consonants, but in some cases syllables may be formed without a vowel .the Czech words are a good demonstration of the point:(prno, vltava) where these syllables consist of consonants only.

One third of the studied languages use consonants only to form syllables. (C. Hagége.p:24)German and English are

among those languages but Arabic is excluded from that since its phonological system rejects two consecutive consonants.

The German word abend is pronounced abant in careful speech, where as in connected speech is pronounced (abnt) or (abmt) , likewise English words bottle and button are pronounced / bɒtl/, /bʌtn/. Sylllabic consosnant appear because of the deletion of the weak vowel schwa.(Peter Roach, 1991: 106)

Types of syllables:

There is a controversy about the number of syllables in Arabic, Some linguists argue that there are six types, but others said there are only five. They are as follows:

1. **The minimal syllable**: It consists of a consonant and a vowel. They are meaningful linguistic units, they consist in prepositions e.g. bi ,fi,li…etc.
2. **Closed long syllable**: It consists of a consonant, a vowel and a consonant.eg. mithl (like) min (from) bal(rather)
3. **Open long syllable**.It consists of a consonant and two vowels.eg. maa, haa

Two forms related to the pause.

4. **Long syllable closed with a consonant :**A consonant+two vowels +a consonant e.g. kaan (was)
5. **Long syllable closed with two consonants**.A consonant + a vowel + two consonants e.g. karb, fadl (A. M. Kaddour, 1999)

Data base:

Arabic language contains 28 consonants, 6 vowels; 3 long vowels represented in three consonants waw, ja, and alif , and 3 short vowels represented in three diacritic marks fathat, dammat and kasrat, and the absence of the mark referred to as sukun.The list of consonants starts with the /ʔ/ sound known as ***hamza*** and ends with the /j/ sound. To get a simple unit one short vowel is added to a consonant e.g. b+a, by contrast to get a complex unit many combinations are made as shown above in types of syllable. Short vowels, long vowels, and minimal syllables are displayed in the following tables.

Table of vowels

Number	Arabic written form	latin written form	phonetic transcription
short vowels			
1	ُ	***DAMMA***	U
2	َ	***FATHA***	A
3	ِ	***KASRA***	I
Long vowels			
1	و	***WAW***	u:
2	ا	***ALIF***	a:
3	ي	***YAE***	i:

Table of minimal syllables

Number	Arabic written	Latin written	Phonetic transcription

	form	form	
1	ءَ	A	ʔa
2	ءُ	U	ʔu
3	ءِ	ɪ	ʔɪ

As far as knowledge base is concerned, it should be noted that three words containing the minimal syllable/ **ʔa/** located in first, mid and final position were recorded by 30 speakers then segmented and as a result 90 syllables were obtained.

Word	Phonetic transcription	First syllable	Medial syllable	Final syllable
أمر	/ʔamara/	أ /ʔa/		
ثأر	/θaʔara/		أ /ʔa/	
قرأ	/qaraʔa/			أ /ʔa/

Syllables Recognition Using Neural Net Works:

In order to process sound three fundamental phases should be taken into account; Pre-Treatment, Treatment and After- Treatment phases.

In Pre- Treatment phase, words are recorded (known as speech prior analysis) over a microphone, then segmented into syllables to process the sound. It is the starting point

which helps in automatic treatment. Then move to the next phase known as treatment phase where analog signal is converted into digital one in order to get the spectrum known as the identity card of the sound because it contains numerical values, that is, frequencies, amplitude, and periodicity. And then to move to the final phase called after-treatment phase where characteristics of the signal are injected in the neural system as an input e.g. formants F1 F2 F3 F4, periodicity, and amplitude, then try to train the system to make an association between input and output.

Before all, it should be noted the nature of this work requires the use of symbols to codify data so as to be comprehended by the machine using Neural Net Works. The code of this data is represented into letters and numbers. The letters used for code are: A,h,d,m ,g and f .A represents the minimal syllable Known as ***hamza*** in Arabic and a short vowel**.** The **(h)** stands for (homme), the(**d)** means (debut),that is, the beginning. The(**m)** means the medial syllable ,and the (**g)** means garçon.
As far as the letter *f* is concerned, there are two; one means final and the other means femme (woman). As for the numbers, they represent speakers. The words mentioned above were recorded by30 informants of different sex and age; 5men, 5women, 5boy
and5girls .Then segmented to have the minimal syllable referred to as ***hamza*** located in first, mid and final position.

Two charts are used for the process of recognition; one represents the referential sample and the other the test sample. We mean by referential sample input and output of

sounds. Input encompasses numerical values of formants, amplitude and period, while output represents the recorded sounds**.** Training Neural Net Works to recognize sounds requires three things ;frequency of formants, amplitude and period which are put in the upper layer as nodes, then connected to a hidden layer which is connected to a lower layer that represents output.

Table showing the characteristics of minimal syllable located in first, medial and final position
Referential samples

Sound	F1	F2	F3	F4	Amp	Per
Ahd1	658 Hz	1076 Hz	2668 Hz	0Hz	0.1566 dB	0.0001667
Ahm1	641 Hz	1037 Hz	1692 Hz	2504 Hz	0.2608 dB	0.0001667
Ahf1	580 Hz	928Hz	1621 Hz	2633 Hz	0.2602 dB	0.0001667
Ahd2	775 Hz	1882 Hz	2152 Hz	0Hz	0.1835 dB	0.0001667
Ahm2	768hz	1202 Hz	2231 Hz	0Hz	0.0946 dB	0.0001667
Ahf2	700 Hz	1115 Hz	2144 Hz	0Hz	0.2168 dB	0.0001667
Ahd3	683 Hz	1038 Hz	1359 Hz	2269 H z	0.1609 dB	0.0001667
Ahm3	721	1195	2480	0Hz	0.1600 dB	0.0001667
Ahf3	801 Hz	1098 Hz	1986 Hz	0Hz	0.2894 dB	0.0001667

Ahd 4	**659 Hz**	**1154 Hz**	**2445 Hz**	**0Hz**	**0.1632 dB**	**0.0001667**
Ahm 4	**625 Hz**	**1025 Hz**	**1649 Hz**	**2489 Hz**	**0.1912dB**	**0.0001667**
Ahf4	**640 Hz**	**1069 Hz**	**2660 Hz**	**0Hz**	**0.1635 dB**	**0.0001667**
Ahd 5	**670 Hz**	**1140 Hz**	**2714 Hz**	**0Hz**	**0.1306 dB**	**0.0001667**
Ahm 5	**698 Hz**	**1204 Hz**	**2640 Hz**	**0Hz**	**0.1632 dB**	**0.0001667**
Ahf5	**652 Hz**	**1014 Hz**	**2696 Hz**	**0Hz**	**0.1628 dB**	**0.0001667**
Afd1	**775 Hz**	**1182 Hz**	**2152 Hz**	**0Hz**	**0.1840 dB**	**0.0001667**
Afm 1	**768 Hz**	**1202 Hz**	**2231 Hz**	**0Hz**	**0.0949 dB**	**0.0001667**
Aff1	**700 Hz**	**1115 Hz**	**2144 Hz**	**0Hz**	**0.2194 dB**	**0.0001667**
Afd2	**803 Hz**	**999Hz**	**1649 Hz**	**2541 Hz**	**0.1245 dB**	**0.0001667**
Afm 2	**823 Hz**	**1087 Hz**	**1536 Hz**	**2549 Hz**	**0.1251dB**	**0.0001667**
Aff2	**898 Hz**	**1387 Hz**	**2340 Hz**	**0Hz**	**0.1274 dB**	**0.0001667**
Afd3	**792 Hz**	**1132 Hz**	**1534 Hz**	**0Hz**	**0.0972 dB**	**0.0001667**
Afm 3	**896 Hz**	**1525 Hz**	**0Hz**	**0Hz**	**0.0972 dB**	**0.0001667**
Aff3	**835 Hz**	**1399 Hz**	**0Hz**	**0Hz**	**0.1603 dB**	**0.0001667**
Afd4	**717 Hz**	**1058 Hz**	**1454 Hz**	**2520 Hz**	**0.2603 dB**	**0.0001667**

Afm 4	**835 Hz**	**1020 Hz**	**1510 Hz**	**2644 Hz**	**0.1312dB**	**0.000167**
Aff4	**796 Hz**	**1065 Hz**	**1339 Hz**	**2645 Hz**	**0.1953 dB**	**0.000167**
Afd5	**875 Hz**	**1462 Hz**	**2625 Hz**	**0Hz**	**0.1962 dB**	**0.000167**
Afm 5	**813 Hz**	**1002 Hz**	**1520 Hz**	**2638 Hz**	**0.1286 dB**	**0.000167**
Aff5	**871 Hz**	**1419 Hz**	**2571 Hz**	**0Hz**	**0.2577 dB**	**0.000167**
Agd 1	**683 Hz**	**1038 Hz**	**1359 Hz**	**2269 Hz**	**0.1600 dB**	**0.000167**
Agm 1	**721zH**	**1165 Hz**	**2480 Hz**	**0Hz**	**0.1603 dB**	**0.000167**
Agf1	**801 Hz**	**1098 Hz**	**1986 Hz**	**0Hz**	**0.2899 dB**	**0.000167**
Agd 2	**911H**	**1257 Hz**	**2225 Hz**	**0Hz**	**0.1563 dB**	**0.000167**
Agm 2	**564 Hz**	**1550 Hz**	**2520 Hz**	**0Hz**	**0.1872 dB**	**0.000167**
Agf2	**646 Hz**	**918Hz**	**1255 Hz**	**2180 Hz**	**0.2214 dB**	**0.000167**
Agd 3	**537 Hz**	**1127 Hz**	**1654 Hz**	**2051 Hz**	**0.1878 dB**	**0.000167**
Agm 3	**541 Hz**	**1032 Hz**	**1658hz**	**1818 Hz**	**0.1560 dB**	**0.000167**
Agf3	**653 Hz**	**983Hz**	**1352 Hz**	**2299 Hz**	**0.2275 dB**	**0.000167**
Agd 4	**853 Hz**	**1096 Hz**	**1584 Hz**	**2411 Hz**	**0.1953 dB**	**0.000167**
Agm 4	**763 Hz**	**1243 Hz**	**1635 Hz**	**2528 Hz**	**0.1291dB**	**0.000167**

Agf4	**785 Hz**	**1215hz**	**1782 Hz**	**2416 Hz**	**0.2539 dB**	**0.0001667**
Agd5	**688 Hz**	**972Hz**	**1347 Hz**	**2631 Hz**	**0.1918dB**	**0.0001667**
Agm5	**660 Hz**	**903Hz**	**1460 Hz**	**2595 Hz**	**0.1600 dB**	**0.0001667**
Agf5	**743 Hz**	**905Hz**	**1271 Hz**	**2605 Hz**	**0.1606 dB**	**0.0001667**

Test sample

Sound	**F1**	**F2**	**F3**	**F4**	**Amp**	**Per**
Ahd6	**796Hz**	**1239 Hz**	**2206 Hz**	**0Hz**	**0.2603 dB**	**0.0001667**
Ahm6	**733Hz**	**1213 Hz**	**2627 Hz**	**0Hz**	**0.1320 dB**	**0.0001667**
Ahf6	**747Hz**	**1143 Hz**	**2684 Hz**	**0Hz**	**0.2278 dB**	**0.0001667**
Ahd7	**714Hz**	**1075 Hz**	**2028 H**	**0Hz**	**0.1638 dB**	**0.0001667**
Ahm7	**672Hz**	**1085 Hz**	**2054 Hz**	**0Hz**	**0.1652 dB**	**0.0001667**
Ahf7	**565Hz**	**1552 Hz**	**2505 Hz**	**0Hz**	**0.2275 dB**	**0.0001667**
Ahd8	**663Hz**	**1134 Hz**	**2326 Hz**	**0Hz**	**0.1641 dB**	**0.0001667**
Ahm8	**602Hz**	**1037 Hz**	**2374 Hz**	**0Hz**	**0.1353 dB**	**0.0001667**
Ahf8	**602Hz**	**1037 Hz**	**2374 Hz**	**0Hz**	**0.1359 dB**	**0.0001667**
Ahd9	**670Hz**	**1068 Hz**	**1750 Hz**	**2641 Hz**	**0.1600**	**0.0001667**

					dB	
Ahm9	661Hz	1088 Hz	2543 Hz	0Hz	0.0998 dB	0.0001667
Ahf9	632Hz	976Hz	1689 Hz	2634 Hz	0.1312 dB	0.0001667
Ahd10	714Hz	1209 Hz	2474 Hz	0Hz	0.1635 dB	0.0001667
Ahm10	691Hz	1167 Hz	2329 Hz	0Hz	0.1910 dB	0.0001667
Ahf10	642Hz	994Hz	1498 Hz	2315 Hz	0.1626 dB	0.0001667
Afd6	466Hz	1210 Hz	1659 Hz	0Hz	0.1635 dB	0.0001667
Afm6	502Hz	1217 Hz	1681 Hz	0Hz	0.2280 dB	0.0001667
Aff6	661Hz	1030 Hz	1580 Hz	2477 Hz	0.1970 dB	0.0001667
Afd7	777Hz	1082 Hz	1604 Hz	2528 Hz	0.0966 dB	0.0001667
Afm7	946Hz	1581 Hz	2692 Hz	0Hz	0.1280 dB	0.0001667
Aff7	687Hz	969Hz	1491 Hz	2562 Hz	0.1009 dB	0.0001667
Afd8	691 Hz	971Hz	1387 Hz	2475 Hz	0.1280 dB	0.0001667
Afm8	599Hz	880Hz	1448 Hz	2815 Hz	0.1632 dB	0.0001667
Aff8	505Hz	1009 Hz	1260 Hz	2522 Hz	0.1973 dB	0.0001667
Afd9	815Hz	1053 Hz	1540 Hz	2601 Hz	0.1956 dB	0.0001667
Afm	849H	1384	2610	0Hz	0.1312	0.00016

9	**z**	**Hz**	**Hz**		**dB**	**67**
Aff9	**858H z**	**1428 Hz**	**2706 Hz**	**0Hz**	**0.1629 dB**	**0.00016 67**
Afd1 0	**1020 Hz**	**1461 Hz**	**2366 Hz**	**0Hz**	**0.1944 dB**	**0.00016 67**
Afm1 0	**1041 Hz**	**1599 Hz**	**0Hz**	**0Hz**	**0.1312 dB**	**0.00016 67**
Aff10	**752H z**	**888H z**	**1308 Hz**	**2351 Hz**	**0.2278 dB**	**0.00016 67**
Agf6	**791H z**	**983H z**	**1353 Hz**	**2274 Hz**	**0.2545 dB**	**0.00016 67**
Agd7	**795H z**	**1184 Hz**	**1601 Hz**	**0Hz**	**0.2231 dB**	**0.00016 67**
Agm 7	**565H z**	**1552 Hz**	**2505 Hz**	**0Hz**	**0.2228 dB**	**0.00016 67**
Agf7	**634H z**	**1015 Hz**	**1547 Hz**	**2295 Hz**	**0.2545 dB**	**0.00016 67**
Agd8	**873H z**	**1074 Hz**	**1497 Hz**	**2377 Hz**	**0.1289 dB**	**0.00016 67**
Agm 8	**896H z**	**1240 Hz**	**1595 Hz**	**2428 Hz**	**0.1956 dB**	**0.00016 67**
Agf8	**801H z**	**1028 Hz**	**1235 Hz**	**2269 Hz**	**0.1312 dB**	**0.00016 67**
Agd9	**565H z**	**1552 Hz**	**2505 Hz**	**0Hz**	**0.1635 dB**	**0.00016 67**
Agm 9	**925H z**	**1538 Hz**	**2373 Hz**	**0Hz**	**0.1317 dB**	**0.00016 67**
Agf9	**776H z**	**1205 Hz**	**1979 Hz**	**0Hz**	**0.1915 dB**	**0.00016 67**
Agd1 0	**947H z**	**1318 Hz**	**2645 Hz**	**0Hz**	**0.2205 dB**	**0.00016 67**
Agm	**918H**	**1434**	**2684**	**0Hz**	**0.1439**	**0.00016**

10	**z**	**Hz**	**Hz**		**dB**	**67**

NNW with ordered data				
Number Of NNW	**Number of layers**	**Number of nodes**	**Number of steps**	**Error rate**
1	**1**	**2**	**150**	**0.9783**
2	**1**	**3**	**150**	**0.9703**

Agf10	**581Hz**	**887Hz**	**1191 Hz**	**2513 Hz**	**0.1919**	**0.0001667**

Many experiments represented in eight Neural Net Works have been done in this work to show which one can bring better results; four Neural Net Works with ordered data,

3	**1**	**4**	**150**	**0.9791**
3	**1**	**5**	**150**	**0.9791**
NNW with non ordered data				
Number Of NNW	**Number of layers**	**Number of nodes**	**Number of steps**	**Error rate**
5	**1**	**2**	**150**	**0.0074**
6	**1**	**3**	**150**	**0.0060**
7	**1**	**4**	**150**	**0.0047**
8	**1**	**5**	**150**	**0.0032**

while four other Neural Net Works with non ordered data. As far as NNW with ordered data are concerned, we have the following:

Neural Net Work number 1 consists of one layer ,two nodes , 150 steps and the error rate is 0.9783.the second net is of 1layer, three nodes,150 steps and error rate of 0.9703.the third net is of one layer, four nodes ,150 steps and error rate 0.9791.Net work number four ,however, contains 1layer five nodes ,150 steps and error rate of 0.9791.

As regard NNW with non ordered data they are displayed as follows:

NNW 5 contains 1layer, two nodes, 150 steps and error rate 0.0074.

NNW6 has 1layer, three nodes, 150 steps and error rate0.0060

NNW7 is of 1 layer, four nodes, 150 steps and error rate of 0.0047, while NNW 8 has an error rate of 0.0032 with one layer five nodes and 150 steps.

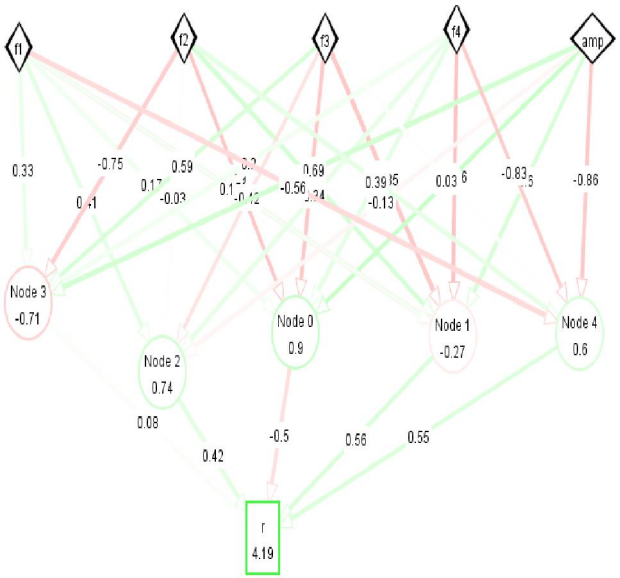
The optimal NNW is Net work number 8 with one layer five nodes and 150 steps and error rate of 0.0032.

Conclusion

This research is an attempt to recognize Arabic minimal syllables automatically relying upon Neural Net Works; one tool of scientific matters which was applied hinging on the random simple sample represented in 90 samples recorded by 30speakers from different age and sex. The optimal Neural Net Work is that of non-ordered data base, it consists of one layer, five nodes and 150 steps, because it gives a satisfying error rate and works better than that with ordered data, more simply put the principle of automatic recognition of one syllable is the same for the other syllables and same even for other languages though different in their phonological system.

It can be safely said that despite the great effort devoted to this humble research, it is considered as a first step to recognize one type of Arabic syllables automatically called minimal syllable, however much work still needs to be done for automatic recognition of all the types of syllables to expand the knowledge base, so that computer specialists will be able to join them and convert Arabic speech into manuscript.

The following design represents the appropriate net work chosen in our work. It comprises one input layer of sound characteristics represented in F1, F2, F3, F4 and amplitude, one hidden layer of five nodes and one output layer called result.



150 Steps .Error rate 0.0032

References

1-Ahmed. Mohammed Kaddour.Mabadie allissaniat second edition 1999 Beirut,Lebanon.

2-Aljahid.albayan wa Tabyin Abu Amru ibn Bahr died in Basra in 255 H.proofread by Darwish Jawidi.

3-C. Hagége. La structure des langues 6eme édition collection fondée par Angoulvent encyclopédique.
4-H. Abdelouhab collection Almoujtamaa introduction à la phonétique orthophonique Arabe. Préface office des publications universitaires 1place centrale de Benaknoun Alger 1984
5-Henry Flesh. Nahwa binaa jadid edited translated and proofread by doctor Abd Sabour Shahin.first published in 2007 in Jordan.

6-Ibrahim Aniss. Alaswat allughawia.fourth edition 1971.published in AngloEgyptian library 165 avenue Mohammed Farid. Cairo.

7-Joe.Tebelskis. Speech Recognition Using Neural Net Works May 1995.CMU-CS-95-142. School of computer science Carnegie Mellon University.Pitsburg ,Pennsylvania15213-3890

8-The Hutchinson Encyclopedia 1999 edition

9-Lawrence. Rabiner &Bing Hwang Juang Prentice. Fundamentals of Speech Recognition. Hall International-Inc Published by PTR Prentice Hall,Inc.ASimon and Schuster Company Englewood Cliffs,NewJersey07632

10-M. Peinado. Speech Recognition Over Digital Channels Robustness and Standards Antonio University of Granada, Spain Jos´e C. Segura .University of Granada, SpainWafaa Niar.

11-Mubarak .Hanun. Fi asiwata azamania alwaqf fi lisaniat alklassikia . published in Rabat.

12-Peter. Roach. Introducing phonetics. published by the penguin group in 1991.Ph Matthews Oxford concise dictionary of linguistics oxford university press.

13-Reinier. Plomp. The Intelligent Ear on the Nature of Sound Perception. Professor Emeritus.Free University AmsterdamLawrence Erlbaum Associates, Publishers2002 Mahwah, New Jersey London.

14-San. Duanmu. Syllable Structure. The Limits of Variation..Great Clarendon Street, Oxford ox2 6DPOxford University Press is a department of the University of Oxford.It furthers the University's objective of excellence in research, scholarship,and education by publishing worldwide in Oxford New York.First published in 2008

15-W.N.Dinedane .L'Intelligence Artificielle Elément de Base.office des publications Universitaires .04-1995codification 2.10.3997

16-W. Street. Oxford Advanced learner's Encyclopedia dictionary. The ideal study dictionary for language and culture. Oxford university press Oxford .ox26Dp.new 8th edition 2010.