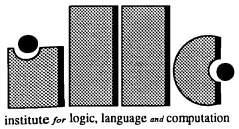

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PROGRAMMABLE GRAMMAR OF THE KURDISH LANGUAGE

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Abstract

All information given by sentences is composed by grammatical rules. This paper attempts to find an engineering configuration model capable to generate the sentences of Kurdish by computer. A system of variables is proposed to load the locations by the elements of the sentences. Such task needs a programmable grammar for the morphology and the syntax. By this grammar we are capable to generate or to produce sentences, and to realise all grammatical possibilities by computer. The program can also treat the Kurdish irregular verbs.

INTRODUCTION :

The linguistic aspect of this research was realized in 1985-1991 and the programature was done in 1992-1993, in the college of engineering at university of salahadin. At that time there were no important publications on computational linguistic or programmable grammar available in our regional libraries. For this reason we have used some selected papers having a relation with Kurdish grammar or with programming. This task was very hard but we have arrived in the end to realize a relation between the grammar and the programmature. In these few pages, we will only describe the methodology of the programmable grammar and some important features of Kurdish grammar. This paper does not explain all the details of the project, which covers more than 300 pages.

During the second half of this century a great development in English grammar occurred (1, 2). The transformational grammar replaced the traditional or classical grammar. However there haven't been any new or distinctive approaches to Kurdish language apart from that of the second quarter of this century(3, 4). To the best of our knowledge FATAH(5) and AMIN(6) tried to improve the traditional grammar of 1928 and 1929, (3, 4). These papers will be analyzed and discussed later.

In the following pages we will first study the forms and their flexibility in the verbs and the sentences and we will construct a configuration for all the components of the verb structure. After this we will propose a configuration pattern for the sentences and its programming method in computer applications. We will also discuss its response to and its advantages in linguistic studies. At the end we will offer the conclusions.

For the technical terms, some new ones can be seen here. The terms "location" and "box" are used for analytical positions for the element in the mind or in the sentence's general configuration while the term

"charge" , "load" or "element" are used for what will be present in the location in the configuration. The term"configuration" represents an engineering drawing containing the entire number of locations while the term "empty boxes" represents the locations not realised in speaking but yet existing in the mind. The term "mobile" means that the location is mobile when it is charged by an element.

VERB CONFIGURATION :

In this part of the project, we will speak about the form of the locations and how we can construct an engineering configuration by them. In the next parts the charge of these locations will be explained.

Now, if the location of the radical of the verb is taken as the origin, there will be other locations in both the left hand and right hand sides. Other elements should be used for each sentence and they can be arranged in their own locations (boxes). The form of the verbs is flexible (elastic) and it can be elongated or shortened according to the sentence taken in consideration.

Left hand expansion:

If a transitive verb, like girtin(*to take*), is taken in the used examples, it can have six successive forms in the grammar of the language, as shown in figure 1.

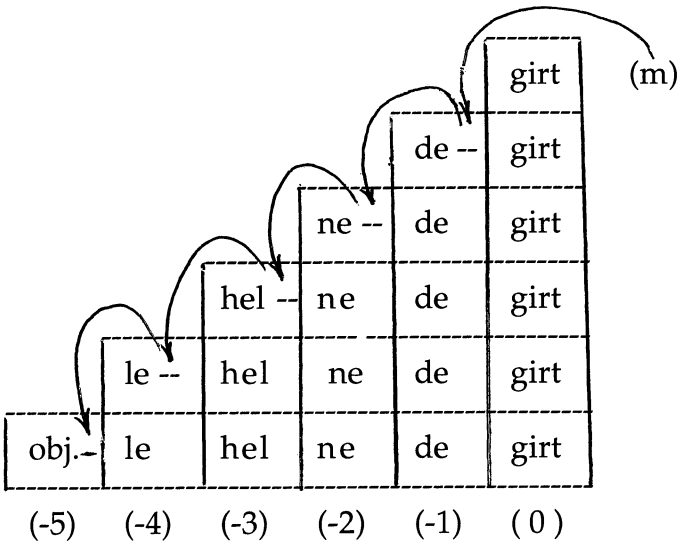


figure 1 (see appendix 1 for the meaning of the sentences)

In these examples it is seen that the shortest form can be changed by loading five empty boxes as shown in the bottom row. The load or charge

is called VARIABLES in this research and it has the following features in this configuration :

_ The load of each box is the same in vertical direction while each row is a grammatical form and a useful sentence for the verb used.
_ Each element has a determined position which cannot be changed.
_ The personal pronoun (m) jumps from its initial station on [girt] to the next left hand box and it can have up to five jumps.
_If any variable is not needed, it can be eliminated. its location becomes a empty box and the verb form will be shortened.
_ The complexity level of each form can be estimated by the number of the sloaded boxes.
_The potential level of each variable (element) can be determined by the distance between its box and the box of the radical [girt].

The configuration in figure (1) contains another configuration for the empty boxes (figure 2). These boxes can be neglected in speaking or writing but they are always present in the mind. The forms contained in them are able to generate 26 new grammatical forms (figure 3), in addition to the 6 forms shown in figure(1). For example the third row which contains 2 empty boxes is able to generate 3 new forms by loading them by their own elements, as follows :

[hel] [---] [---] [girt]

[hel] [ne] [---] [girt]

[hel] [---] [de] [girt]

[hel] [ne] [de] [girt]

All of these forms are grammatical sentences in the language and in total there are 32 possible forms corresponding to 32 examples. In figure (3), we have shown all the forms and they are numbered from 1 to 32. A little consideration will show that the 26 new sentences are generated by the activity of the empty boxes in the forms (3, 4, 5 and 6), shown in figure (2). Now if we study the deformability of the form, we will be able to classify them into:

- Hard forms: Like the forms (1, 2, 7, 10, 17 and 32). These forms don't contain empty boxes and they aren't deformable to a longer form, as in figure 1 .

- Soft forms:All the other sentences contain empty boxes and they are flexible or deformable forms.

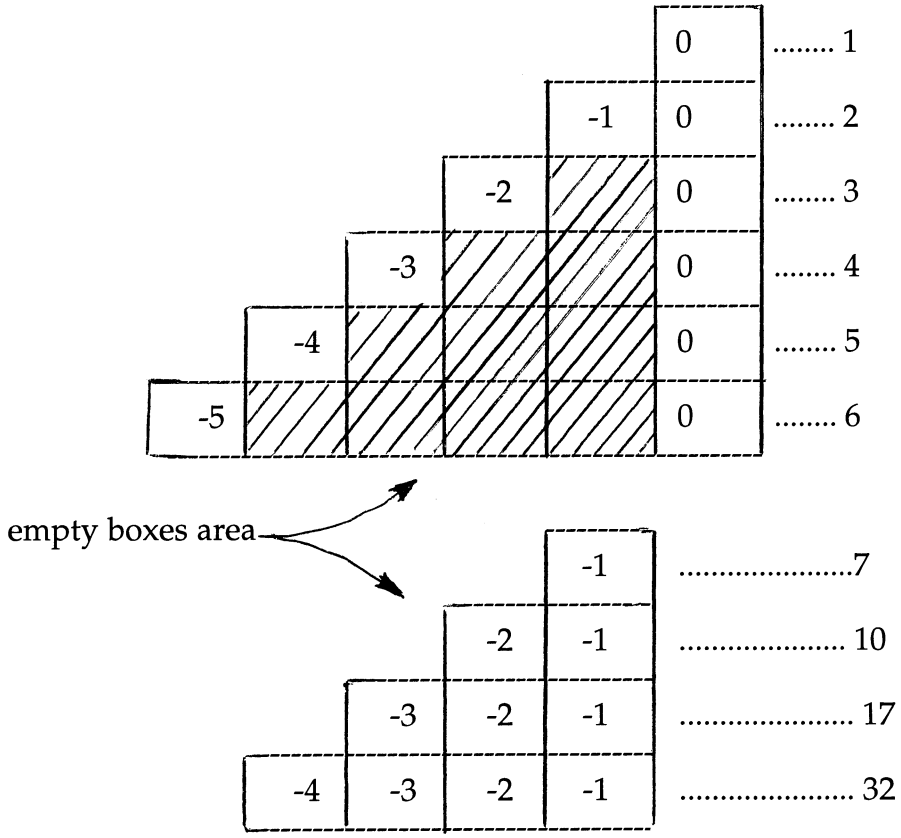


figure 2

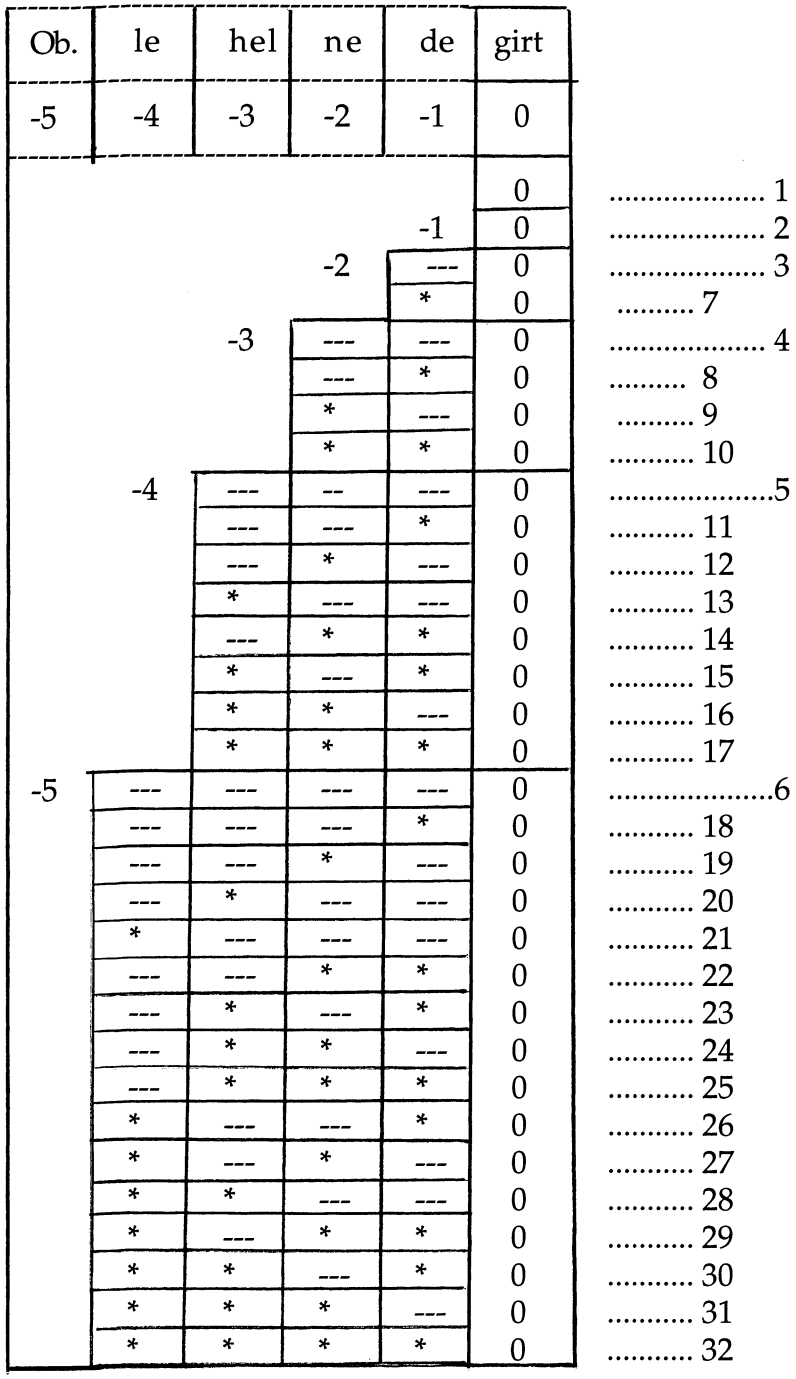


figure 3
[*] : charged boxes
[---] : empty boxes

Right hand expansion:

The right hand side of the verb, as the left hand side, can be extended because it has also a flexible form or an elastic behaviour. The deformability of the root permits 5 additional boxes existing in the mind and at the right side. This means that box [0] in figure 1 or in figure 2 can generate another configuration. Now if an intransitive verb like soutan (*to burn*) is taken in to consideration the configuration shown in figure 4 is obtained.

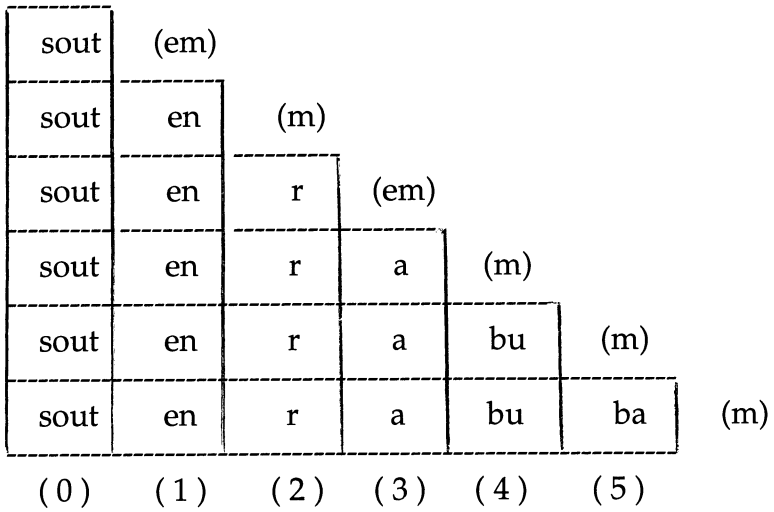


figure 4 (see appendix 1 for the meaning of the sentences)

Here also there is an arrangement for the successive boxes and the following features can be noted :

- _ The charge of the boxes is the same in vertical direction and each row is agrammatical form for the root of the verb.
- _ The position of the boxes is fixed : it can not be changed or be replaced by an other one.
- _ This configuration shows a concrete distribution for the boxes according to the tense of the verb (figure 5).
- _ According to figure 5, the imperative boxes are situated in the present area which is built up by the element of the verb foundation area, while the past area has 3 additional boxes added to this area. This means that the present tense is the foundation in our language.
- _ The verb foundation area controls the "transitive : intransitive" and the "active : passive" transformations.
- _ If any element is not needed it can be eliminated and the form of the verb will be shortened in speaking or in writing but it stays in the mind.
- _ The charge of the box [0] is an indivisible part of the verb and it is present in all the sentences . It can be considered as the origin

for the elements of the verbs and the sentences in the language.

_ Here also the complexity and the potential levels can be determined by the number of the boxes used and their distance from the origin as explained for figure 1.

The right hand configuration will react with the 32 possible forms of the left hand side to increase the number of grammatical forms to 528. These combined forms will cover the surface of the programmable grammar.

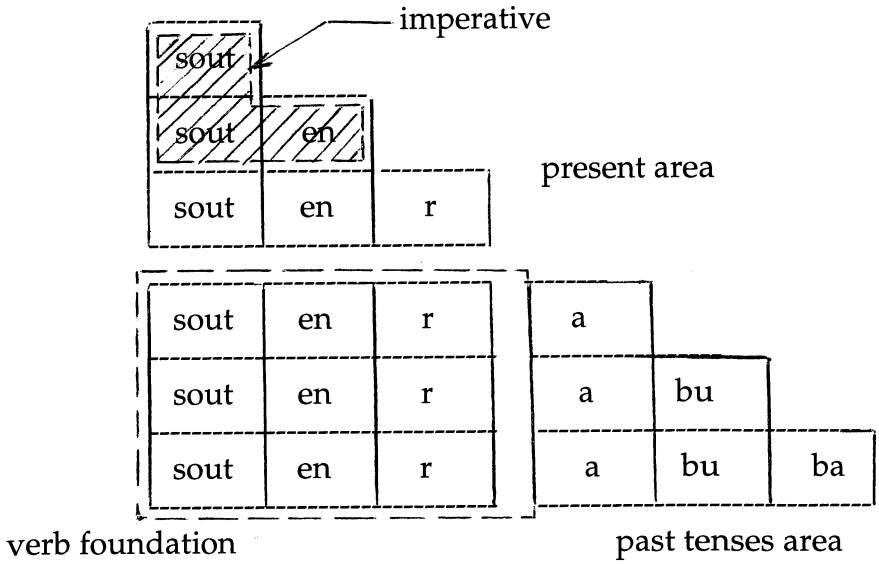


figure 5

Total configuration of the verb:

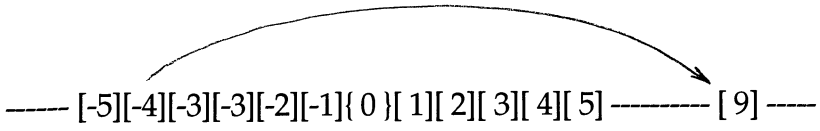
The right hand and the left hand expansion of the verb form can be assembled together for obtaining the total configuration, called here VERB CONFIGURATION, as shown in figure (6). We have also added the corresponding elements of the boxes in a table below. These charges can be classified in three groups :

1. Linguistic elements, like the elements of the boxes [-1]. [-2], [1], [2], [3], [4], [5]. It can be said that they are the particular linguistic soft elements of the language.

2. Lexemes, like the boxes [0] and [-5]. Their charges can be found in dictionaries.

3. Grammatical tables, like [-3] for meaning changers and [-4] for prepositions. The two boxes can be charged by noun phrases.

The verb configuration can be substituted by its longest row which contains all the boxes to be used as a STRING of 11 locations as shown below. The box [-4] could have an other position at the end of the sentence. This operation minimizes the complexity and it has no effect on the meaning. The new position of the box [-4] is numbered as [9] in the following pages



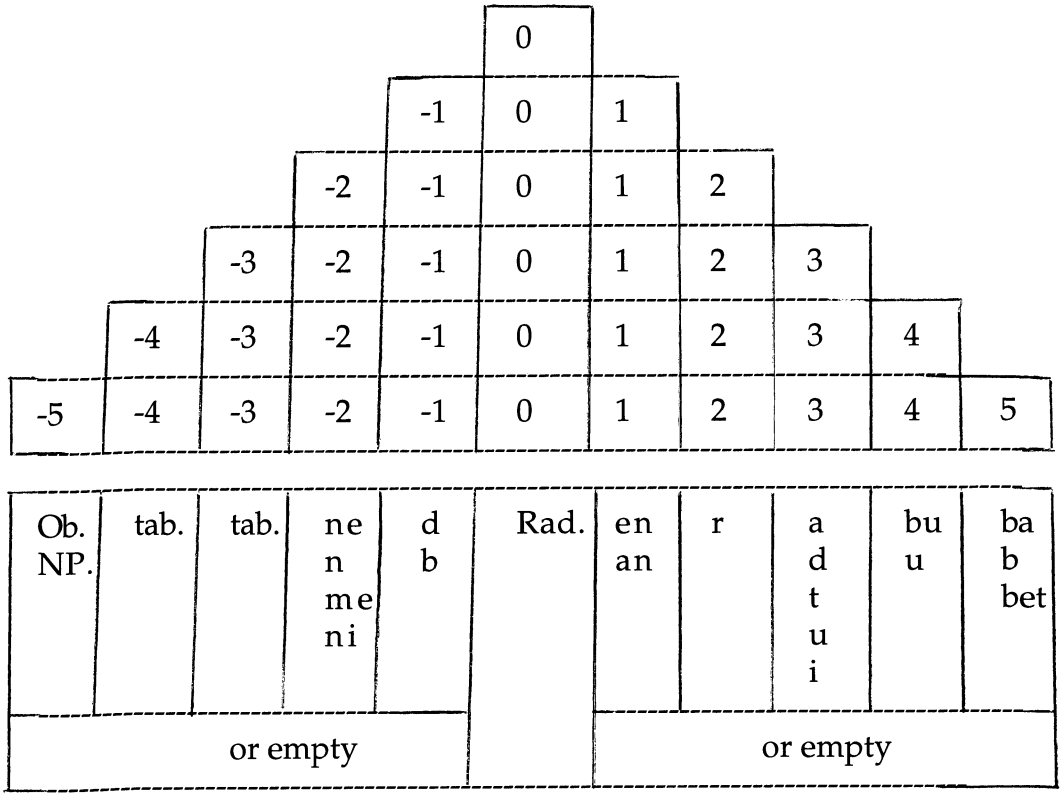


figure 6

FUNCTION OF THE VARIABLES:

The charge of the boxes can be considered as variables for the radical [0] which is usually loaded in the sentences. The other elements on both sides can be classified as external variables(left hand side) and internal variable(right hand side). The externals are separate elements added to the verb while the internals belong to the verb root.

The radical [0]:

The charge of this box is the RADICAL and it can be determined from the radical infinitive of the verb as in the following equation:

Radical infinitive= radical + past sign + {letter N}
Or radical = radical infinitive - past sign - {letter N}

The radical can be found in the radical infinitive. The past sign is the charge of the box [3] and the letter {N} is common for all the infinitives.

External variables:

_ Box [-1] : It has only two possible charges [de] for indicative, or [b] for subjunctive or it would be empty. This variable introduces the continuity to the action in present and continuous past tenses.

_ Box [-2] :It has a unique [ne] for negation and it is empty in affirmative forms . This element could react with the charge of [-1] according to the following equations:

[ne] + [de] = [na], in present.
[ne] + [b] = [ne], in subjunctive(present).
[ne] + [b] = [me], in imperative.
[ne] + [--] = [ni], in present (verb to be and to have).

_ box [-3] : The charge of this box is the prefixes and their function is meaning changing like "on" and "off" in the verbs" go on" and "take off" in English.

_ box [-4] : This is for prepositions and their charges.Its function is to introduce a directional element to the action.

_ box [-5] : The charge of this box is the separate direct object in transitive sentences.

Internal variables :

_ Box [1] : It is reserved for the element [en]; it transforms the intransitive forms into transitive ones, like "to burn" and "to burn some thing" in English.
_ Box [2] : Its charge is [r] and its function is transforming active sentences to passive ones
_ Box [3] : This location is reserved for one of the past signs [a, t, d, i and u] in the past tenses only. It transforms the present forms to the simple past.
_ Box [4] : Its charges are [bu] or [u] and it transforms the simple past forms to pluperfect and perfect tenses.
_ Box [5] :This box transforms the past forms into subjunctive or conditional forms when it is charged with one of these elements [b], [ba] or [bet].

The box of radical [0] and the boxes [1] and [2], in the internal variables, are situated in the verb foundation area and they construct the foundation grammar of the verb. In these locations we will find five terminals in the mind for the sentences. The details of this part will be written separately in another paper.

For other works concerning the grammatical configurations and strings, FATAH (5) and AMIN (6) offered an arrangement for the elements of verbs and sentences. This work is confined to two approaches that have a direct relationship with some parts of our research:

1. Grammar of the personal pronouns, AMIN (6).
2. Classification of the verbs, FATAH (5).

AMIN wrote about the mobility of pronouns in a very complex manner and he has proposed several formulas to explain the subject of his research. However some problems have been left, such as:

A. The negative element is not taken in to consideration, while it is an obvious location for the mobile pronouns. For example we can say:

[ne](m)[girt](--). (*I did not take*)

B. The jumps of mobile pronouns are counted from the end but should be considered from the original location which is the root of the verb, as shown below:

[ob.](m)[le](--)[hel](--)[ne](--)[de](--)[girt](--).

In this configuration the mobile pronoun stops at the extreme

right if the left hand boxes are empty.

C.The paper does not fix decisively the original location for the mobile pronoun on the root. In such a task the origin or the initial station must be fixed for the next successive jumps.

FATAH has also classified the verbs in actives and passives and he has proposed two strings for each one. The verb elements have been arranged within them. They are termed variables in this paper. However here also there are some remarks like :

A. He has proposed one box for [de, ne, b] but in reality [ne] must be written in a separate box, as [ne] and [de, b] . For example one could say:

[ne](m)[de](--)[girt](--). (*I was not taking*)

B. He has also proposed one box for [a, nd] but they are better written in two free boxes separated by the box of passivity, as :

[sout][an][--][d](m). (*I burnt something*)

For the passive transformation the box [+2] can be loaded, as in the following example :

[sout][en][r][a](--). (*something was burnt*)

These works will have a direct relationship with some parts of this research like the mobility of pronouns and the verb morphology. Other researchers have studied some elements of the verbs and sentences but they haven't offered an arrangement for the elements. The works of AMIN and FATAH can be arranged and deepened with the aid of the verb configuration as it is explained in this research.

SENTENCE CONFIGURATION:

In addition to the 10 variables of the radical [0] in the string of the verb other locations can be added to transform it to a general string for the sentences. These locations are :

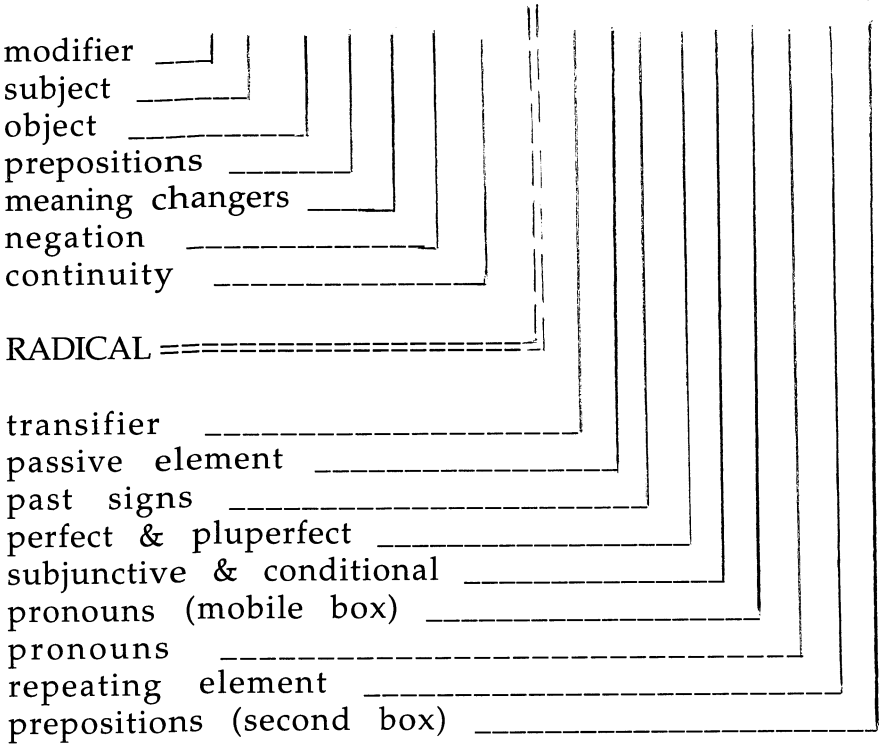
_ Explicit subject, the box [-6].
_ Sentence modifier. the box [-7].

_ Bound subject, the box (7).
_ Bound object, the box (6).
_ Repeating element (ewe), the box [8].

The charge "ewe" is a general element for all the normal verbs and it looks like "re" for the verbs in French. Its function is in general to repeat the action of the verb. It can also change the meaning in some verbs.

Now if these boxes are added to the string or to the verb configuration, a new string will be obtained and it can be called "sentence configuration", as shown below:

----- [-7][-6] [-5][-4][-3][-2][-1] {0} [1][2][3][4][5] (6)(7) [8] [9] -----



This string was used as a general configuration for the sentence for programmable grammar in the computer program. It was able to produce and to transform the sentences of the language.

In the preceding pages we have written about the flexibility and the elasticity of the forms. Here it will be interesting to show the significance of the grammatical terms for the flexible form of the general configuration. The terms will be introduced by the answers of the user. Each term will divide up the locations of the general string in to three classes:

- Boxes to be neglected:These boxes must be taken out because they are not needed in the example taken into consideration. The computer will also neglect a number of questions concerning

these locations. For example, if the term PRESENT is chosen on the screen, the boxes [3], [4] and [5] must be neglected.

- Boxes to be loaded:These boxes must be present in addition to the origin {0} or the radical of the verb. Here, the computer is obliged to find its way for loading these locations by their own elements. For the term PRESENT, the box[-1] must be loaded by "de" or "b".

- Optional boxes:All the other boxes are optional and their use will depend on the later answers of the user.

By this mechanism, the program will be guided to shorten the general configuration of the sentences and to reduce the number of questions appearing on the screen. This will also guide the user to the shortest way to arrive at the sentence.

5. COMPUTER PROGRAM :

A computer program was written in the language BASIC which is a comprehensive and simple high level computer language. The phenomenon flow chart explained previously was translated into a step by step computer program(8, 9). The program can be run on any computer such as IBM-PC or compatible with the MS-DOS operating system if it has an Arabic translation supplement .

Arabic lettering was used for input data with a direction of writing from right to the left. English lettering was used for commands and statements with writing direction from right to left.

The program is very simple to run and it can be used by any user without previous knowledge of computer programming. After running the program wait for a few seconds for data loading , and after answering a few elementary questions by "Yes" or "No" and entering a few lexical elements you will get the result. At this stage you are able to continue the program and get different types of sentence forms and you can also transform them to other grammatical cases or to stop the program.

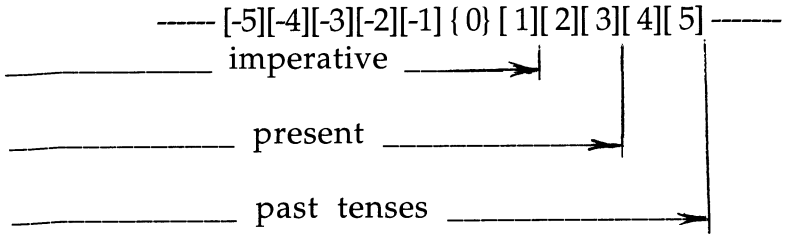
In this program 31 storage areas for lettering were chosen for words and letters which can be expanded to any number required for the configuration pattern of the sentences. Each storage area can carry from 1 to 30 letters or more depending on the place and location of the letter or word in the sentence. The sentence is not stored in the program but the computer will produce it. This means that you can obtain an infinite number of sentences depending on the user's choice and the verb you have.

For the mobile personal pronoun shown in figure 1 box [6] is reserved as a mobile seat in all the cases. If this location is charged it will move according to the label [-1] to [-5] in the program. The full listing of the program "programmable grammar" cannot be shown here but it will be published in another paper.

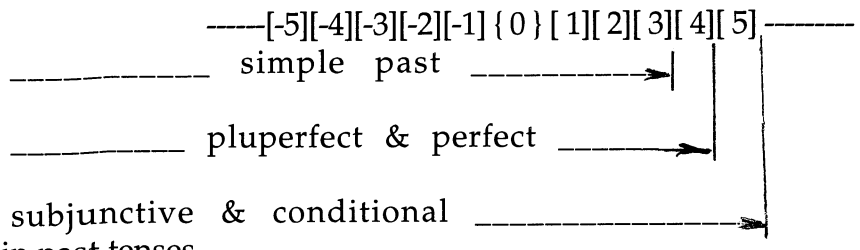
RESPONSES OF THE MODEL:

The configuration model of the sentences can be used in all the following grammatical cases :

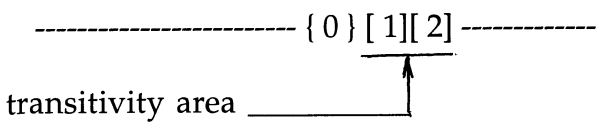
- The tenses: (present, the past tenses) and the imperative can be drawn as shown below :



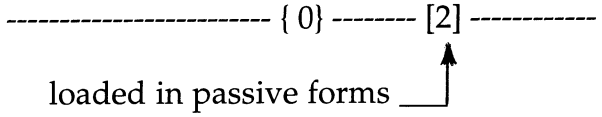
- The past tenses can also be classified on the model as :



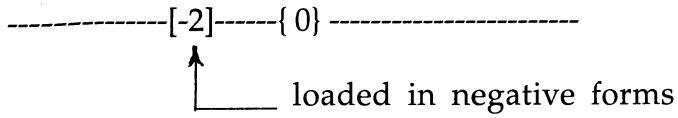
- Transitivity area : The boxes [1] and [2] will cover all the forms for their charge transitive (+) or intransitive (-). When this area is not loaded the charge depends on the radical verb itself.



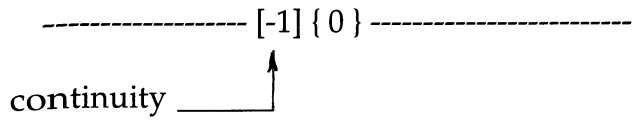
- Passivity : For the passive forms only the box [2] is loaded and it is empty for the indicatives.



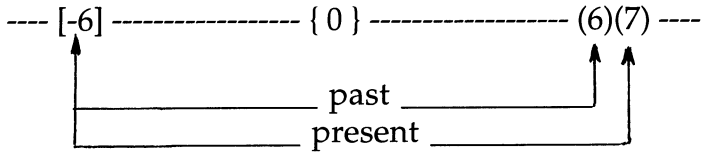
- Negative forms : When box [-2] is loaded the form is negative and it is affirmative if it is empty.



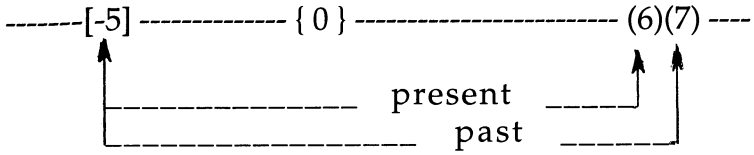
- Continuity : For the present and the continuous past only box [-1] is loaded and it is empty for the other cases.



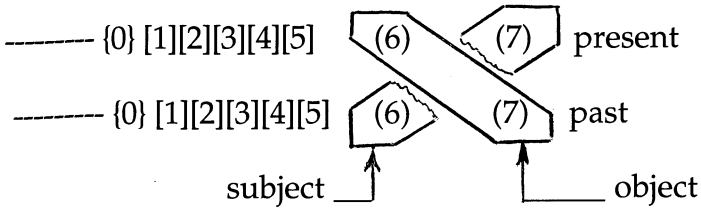
- Subject grammar: There will be two subjects in the sentence. The first is separate and stationary in box [-6] and the second is bound and mobile in past tenses, as shown below :



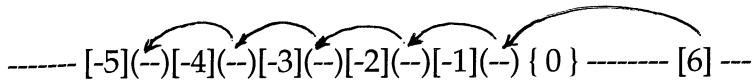
- Object grammar : There are two locations for the object but there will be only one in the sentence. Separate object in box [-5] and the bound object in [7] in past and in the mobile box in the present as shown :



- The two previous points indicate the transformation of functions between the boxes [6] and [7]. They can be drawn in one sketch :



- Mobile location : In all the forms of the sentences box [6] is mobile and only as shown on the sketch while box [7] is always stationary. This separation needed to be solved in the program.



- Word formation: The verb configuration can be used as a word former. All the words derived from the verbs are compatible with the string and they could have additional elements. It can be also used as a form corrector for them.

And so the model can cover all of the grammar, especially the morphology the syntax of the verbs and the sentences.

CONCLUSIONS:

- The elements of the verbs and of the sentences can be arranged in a string of successive locations called the sentence configuration. It can also contain a number of empty boxes, by which the form becomes flexible or elastic.

- The locations are arranged in a regular string of the boxes and it does not accept any change in positions. Any deviation from this pattern will introduce a deviation from the native language and thus be ungrammatical.

- The verb elements can be classified in three groups :soft elements (linguististic elements), grammatical tables, and lexemes.

-The empty boxes disappear in speaking or writing but they are always present in the mind . For example we can turn "I go" to "I don't go" but when it is written we must erase its structure and fill the empty boxes by "do" and "not".

- Each box could have several charges for its grammatical function in the form but one charge is allowed to be present in the box.

- Each box has a potential level according to its distance from the box of origin [0] and its charges will have the same potential. When different elements are used in a sentence, they must be arranged according to their potential levels. In this case, the equivalent potential levels cannot be seen in the same sentences.

- The box of the verb radical [0] is present in all the forms, so that it can be called the invariable core of the sentences, while all the the other boxes can be variable in their form.

- The complexity degree of the verb forms can be estimated by the number of the boxes used in addition to the radical [0].

- The string proposed in this paper can take all sentences and it can be used as a grammatical filter and so it is used in a programmable grammar in the language, yielding all and only the gramatical sentences.

- The total verb configuration permits us to make an engineering drawing or a map showing the fundamental mechanisms for the language. This will simplify the comparison between different languages.

- Finally, the information explained here is arranged in a large flow chart. It has been translated by S. Husein into a computer program in BASIC. It is used as a programmable grammar, and now the following operations can be done by computers and can be seen on the screen :

1. Producing or generating sentences for both regular and irregular verbs.

2. Transforming the generated sentences in all grammatical directions to cover the entire area of the language.

3. Applying several transformations without having any problem due to mutual interaction between them.

4. The produced sentence, shown on the screen, can be disassembled to put its elements into their own boxes in the sentence configuration string and showing also the empty boxes, which are not needed. This will be a useful tool in language learning.

Now, the programmable grammar will have the following advantages:

- Producing and transforming the sentences by computers will prove the correct manner by which the language is analysed.

- When such a grammar is available for a widely spoken language as English, it can be an important tool in language learning.

- The methodology of this research can be used for other languages, and we are able to apply it to English and French as well.

APPENDIX I THE MEANING OF THE SENTENCES

Figure 1
- *I took (something)*
- *I was taking (something)*
- *I was not taking (something)*
- *I was not taking up (something)*
- *I was not taking up (something) from ...*
- *I was not taking up (the direct object) from ...*

Figure 4

- I *burn (intransitive)*
- I *burn something (transitive)*
- I *am burnt*
- I *was burnt*
- I *had been burnt*
- I *would have been burnt*

REFERENCES :

1- O THOMAS & E. KINTGIN.
Transformational grammar and the teacher of English, second edition, Holt, Rinehard and Winston, INC. 1974.

2- B. L. LILES.
Transformational grammar, Prentice Hall,, INC 1971.

3- S. SIDQY.
The morphology and syntax of Kurdish grammar. Baghdad 1928, (in Kurdish).

4- T. WAHBY.
The grammar of Kurdish language, part 1. Baghdad 1929, (in Kurdish).

5- M. M. FATAH.
Classification of the verbs in the Kurdish language KARWAN, No. 121, Baghdad, March 1989, (in Kurdish).

6- W. O. AMIN.
Grammar of personal pronouns. Baghdad 1986, (in Kurdish)

7- *Le nouveau BASHERRELL, art de conjuguer , dictionnaire de 12000 verbs.* HATIER 1980, (in French).

8- D. CASSEL and R. SWANSON.
BASIC for mini and micro computers. P. Hall international, London 1984.

9- " *Microsoft MS-DOS Arabic supplement*" . Microsoft coorporation, USA 1989.

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