

Ukrainian Participles Formation by the Generative Grammars Use

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Abstract. The article deals with the use of generative grammars in linguistic modelling. The description of inflection of participle words is used to model synthesis processes at the morphemic level of language.

Keywords. Generative Grammars, Computational Linguistics

1 Introduction

At the present stage of development, the need to develop common and specialized linguistic systems is forcing applied and computational linguistics to go far beyond their borders - in the field of information technology [1-6]. Developing effective speech models to provide computational linguistic systems will enable a way to perform such applied linguistics tasks as analyzing and synthesizing oral and written texts, describing and indexing documents, translating texts, creating lexicographic databases, and more [9-15]. An effective tool for this type of linguistic modelling is the main part of combinatorial linguistics - the theory of generative grammars, the beginning of which started from the works of the American linguist N. Chomsky [10-13, 16-24]. The advantages of generative grammar modelling are that they can equally successfully describe not only the syntactic level of speech (word formation rules), but also morpheme (word formation rules with morphemes), which can be used to automate word-translation and word-formation processes [1-2, 25-29]. For example, automatic morphological synthesis implies that, based on the set requirements for word-forms, a computational linguistic system, based on morphemes, must be able to form a similar word-form itself [6, 30-48].

2 Analysis of Recent Researches and Publications

Studies of linguists in the field of morphology, morphonology, structural linguistics have identified many different structures for describing word-forms [1, 2, 4, 5, 7, 8, 10]. With the beginning of the development of the theory of generative grammars, linguists have focused not only on the description of finished word-forms, but also on the processes of their synthesis [8]. In Ukrainian studies, a lot of useful information

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was gathered during morphologists researches in functional part of this case, in particular theoretical problems of morphonological description, questions of classification of morphemic and word-forming structure of derivatives of Ukrainian language, regularities of affix combinatorics, modelling of word-formation mechanism of modern Ukrainian language in vocabulary of organization distinctive verbs and suffixes with a denominative meaning, problems of word-forming motivation in the formation of derivatives, the laws implementing morphonological phenomena in Ukrainian word formation, morphonological modifications in the verb inflection, morphonological processes in inflection and word formation of adjectives modern Ukrainian literary language, etc. [4]. The dynamic approach of modern linguistics to the study of the morphological level of language, when the researcher's attention is focused on the study of morphological rules, allows effective application of the results of theoretical research in practice - for the construction of computer linguistic systems of various purposes. One of the first attempts to apply the theory of generative grammars to linguistic modeling belongs to Gladkyi and Melchuk [1-2].

3 Article Goals Formation

Linguistic support is used in all computer systems without exception, and improving human-machine communication is an important challenge that can be solved by improving the process of synthesizing texts at the morphemic level. To improve this, let review the process of linguistic modelling of the synthesis of participles in Ukrainian language with help of generative grammars. To do this, a proper description of the word systems must be finished - to determine, based on a morphological analysis, a list of corresponding morphemes, and to find out a system of rules by which any correct forms of participles can be obtained without obtaining any wrong ones.

4 Scientific Results Analysis

The participle is a changeable, grammatically formed from verb tense forms, characterized by the features of the verb and adjective [5, 9], for example: “*Тепле повітря навкруги було напоєне пахоцями степових квітів*” (О. Гончар); “*І їхній ксьондз, небритий півзими, закутаний в тугейші килими*” (Л. Костенко); “*Повезли мою матір на білих волах, неоплакану матір, неоплакану матір*” (Л. Костенко). The basis of the participle is the basis of the verb, so the basic properties of the verb are the properties of the participle. To illustrate, let's do a morpheme analysis (parse) and define word formation rules for several randomly selected Ukrainian verbs.

At the morphemic level, units of language are morphemes (chains of phonemes for oral language and chains of letters for written language), a strictly ordered morpheme chain forms a lexeme. It has a semantic and grammatical or only grammatical meaning [6]. A typical [6] morpheme chain for Ukrainian language lexemes can be represented as follows:

$$[prefix] + \{root + [interfix]\} + [suffix] + [ending] + [postfix]. \quad (1)$$

The options listed in squared brackets indicate the optional elements of lexemes and the other brackets show morphemes that may be repeated.

Let review the participle word-form as a chain of three or four morphemes: *занізн* + *i* + *л* + *ий*, *змарн* + *i* + *л* + *ий*, *роздрук* + *ова* + *н* + *ий*, *запрограм* + *ова* + *н* + *ий*, *носij* + *a* + *н* + *ий*, *розпил'* + *a* + *н* + *ий*). In this article, the root with the prefix is considered together as one morpheme ("word stem"). Apostrophe indicates the softness of consonants meaning that *л'у* = *лю*, *л'а* = *ля*, etc. Word forms and morphemes are recorded mainly in accepted orthography with transcription, where it is convenient to formulate rules: in some cases, *j* is used to indicate the softness of consonants (only paired soft ones).

For adjectives we distinguish five classes of morphemes given in Table. 1.

Table 1. Morphemic classes for participles

Class	Name	Example
I	Word stem	<i>змарн-</i> , <i>роздрук-</i> , <i>загоj-</i> , <i>заспокоj-</i> , <i>розпил'</i> - etc.;
II	Thematic element (word stem expander)	<i>-и(i,і)/-а(я)/-ол(р)о-</i> ;
III	Suffix for the formation of verbs of the perfective and imperfective aspect of predominantly foreign language origin	<i>-ува-(-юва-)/-овува-/ну-</i> , for example, <i>атакувати</i> , <i>воєнізувати</i> , <i>гарантувати</i> , <i>інтенсифікувати</i> , <i>наслідувати</i> , <i>організовувати</i> , <i>організувати</i> , <i>телеграфувати</i> , <i>телефонувати</i> , <i>яровизувати</i> , <i>засохнути</i> , <i>промокнути</i> ;
IV	Suffix	<i>-л-</i> , <i>-уч-/юч-</i> , <i>-ач-/яч-</i> , <i>-н-</i> , <i>-ен-/єн-</i> , <i>-т-</i> , <i>-ова-</i> etc.;
V	Ending	<i>-а</i> , <i>-і</i> , <i>-е</i> , <i>-у/-ю</i> , <i>-ий</i> , <i>-о</i> etc.

The rules by which morphemes are combined with each other use the following features of a series of morphemes. (Table 2).

I. For word stems:

- (1) transitive / intransitive ($t / \bar{t} / t - \bar{t}$, for example, ($t - \bar{t}$));
- (2) figuration ($d / \bar{d} / d - \bar{d}$), ($d - \bar{d}$) means that following verb is partly homonymous (*автоматизувати*, *досліджувати*, and also *веліти*, *вінчати*, *женити*);
- (3) Grammatical conjugation (I/II);

Table 2. Signs of a range of verbs (for morphemes of the word stem)

Verb	Analysis	Word steam	Participle
автоматизувати(ся)	автоматиз- ува-ти(-ся)	автоматиз- ($t - \bar{t}$, $d - \bar{d}$, I , <i>атем</i> , <i>у</i> , <i>ся - ся</i>)	автоматиз- ова-н-ий
будувати(ся)	буд-ува-ти(- ся)	буд- ($t - \bar{t}$, $d - \bar{d}$, I , <i>атем</i> , <i>у</i> , <i>ся - ся</i>)	буд-ова-н-ий
вести(ся)	вес-ти(-ся)	вес-($t - \bar{t}$, \bar{d} , I , <i>атем</i> , \emptyset , <i>ся - ся</i>)	вед-єн-ий
втрратити втрачати	→ втрат-и-ти → втрач-а-ти	втрач-(t , $d - \bar{d}$, II , \emptyset , \emptyset , <i>ся</i>)	втрач-єн-ий

Verb	Analysis	Word steam	Participle
втручатися	втруч-а-ти-ся	втруч-(\bar{t} , \bar{d} , I, a , \emptyset , $\overline{ся}$)	втруч-ен-ий
досліджувати(ся) →	дослідж-ува-ти(-ся) →	дослідж-(t , $d - \bar{d}$, I, $\%$, \emptyset , $\overline{ся - ся}$)	дослідж-ува-н-ий →
дослідити(ся)	дослід-и-ти(-ся)		дослідж-ен-ий
запізнюватися →	запізн-юва-ти-ся →	запізн-(\bar{t} , d , I, $\%$, \emptyset , $\overline{ся}$)	запізн-юва-н-ий →
запізнитися	запізн-и-ти(-ся)		запізн-ен-ий
кохати(ся)	кох-а-ти(-ся)	кох-(t , \bar{d} , I, a , \emptyset , $\overline{ся - ся}$)	кох-а-юч-ий
любити(ся)	люб-и-ти(-ся)	люб-(t , \bar{d} , II, $\%$, \emptyset , $\overline{ся - ся}$)	любл-ен-ий
малювати(ся)	мал-юва-ти(-ся)	мал'- ($t - \bar{t}$, $d - \bar{d}$, I, $atem$, y , $\overline{ся - ся}$)	малй-ова-н-ий
нести(ся)	нес-ти(-ся)	нес-(t , \bar{d} , I, $atem$, \emptyset , $\overline{ся - ся}$)	нес-ен-ий
побудувати(ся)	побуд-ува-ти(-ся)	побуд-(t , d , I, $atem$, y , $\overline{ся - ся}$)	побуд-ова-н-ий
поділити(ся)	поділ-и-ти(-ся)	поділ-(t , d , II, $\%$, \emptyset , $\overline{ся - ся}$)	поділ-ен-ий
привести(ся)	привес-ти(-ся)	привес-(t , d , I, $atem$, \emptyset , $\overline{ся - ся}$)	привед-ен-ий
розфарбувати(ся)	розфарб-ува-ти(-ся)	розфарб-(t , d , I, $atem$, y , $\overline{ся - ся}$)	розфарб-ова-н-ий
сміятися	сміј-а-ти-ся	сміј-(\bar{t} , \bar{d} , I, \emptyset , \emptyset , $\overline{ся}$)	сміј-уч-ий
спитати(ся)	спит-а-ти(-ся)	спит-(t , \bar{d} , I, a , \emptyset , $\overline{ся - ся}$)	спит-а-юч-ий
стогнати	стогн-а-ти	стогн-(\bar{t} , \bar{d} , I, \emptyset , \emptyset , $\overline{ся}$)	стогн-уч-ий
усміхнутися	усміх-ну-ти-ся	усміх-(\bar{t} , d , I, $atem$, n , $\overline{ся}$)	усміх-н-ен-ий
фарбувати(ся)	фарб-ува-ти(-ся)	фарб-(t , \bar{d} , I, $atem$, y , $\overline{ся - ся}$)	фарб-ова-н-ий
молоти(ся)	мол-о-ти(-ся)	мол-(t , d , I, o , \emptyset , $\overline{ся - ся}$)	мол-о-т-ий і мел-ен-ий
змарніти	змарн-і-ти	змарн-(\bar{t} , d , I, i , \emptyset , $\overline{ся}$)	змарн-і-л-ий

(4) Possibility or need of a thematic element ($a/i/\emptyset/\%o/atem$), where a stands

for need of a thematic element $-a/-я-$ ($пис + a + н + ий$, $чит + a + н + ий$, $розпил + я + н + ий$, $леж + a + чий$); stands for need of a thematic element $-u(i,i)-$ ($змарн + i + л + ий$); \emptyset means that thematic element $-a/-я-$ is possible, but not necessary have to included ($оснів + a + н + ий$, or $оснів + ува + н + ий$); $\%$ means that thematic element $-u(i,i)-$ is possible, but not necessary have to included ($запізн + i + л + ий$, $запізн + юва + н + ий$, $запізн + ен + ий$, $вирішити - вирішувати$, $узгодити - узгоджувати$, $запізнитися - запізнюватися$, $змусити - змушувати$, $загоїти - загоювати$); o means the possibility of forming parallel participle forms for the basics of the infinitive verbs on $-ор(л)о-$ ($колоти - колотий$ and $колений$, $пороти - порений$ and $поротий$, $молоти - молотий$ and $мелений$); $atem$ means that the thematic element is not possible ($вести - ведений$);

- (5) The ability to attach the suffix to the base ($y/\text{ґ}/n/\emptyset$): y means that suffix should be added to the word stem *-ува-/-юва- або -овува-* (*застос + овува + н + ий, будувати*); ґ means that suffix could be added to the word stem *-ува-/-юва- або -овува-* (*заго + юва + н + ий* or *загої + ти, зачитувати, розпилювати, досліджувати, застосовувати, спізнюватися*); n defines the possibility for creating the parallel forms of participles for word stems with suffix *-ну-* (*прип + ну + т + ий, кину(ти) – кинутий* and *кинений; верну(ти) – вернутий* and *вернений; стисну(ти) – стиснутий* and *стиснений; усуну(ти) – усунутий* and *усунений; замкну(ти) – замкнутий* and *замкнений; зігну(ти) – зігнутий* and *зігнений*); \emptyset impossible to add a suffix to the word stem (*некти, запрягти, опасти*);
- (6) Possibility or necessity of adding *-ся* ($\text{сґя}/\text{сґя}/\text{сґя}-\text{сґя}$) – «*сґя*» means the necessity of adding *-ся* (*сміятися, розчервонітися, намерзтися, усміхнутися, зажурилося, втомитися*), « сґя » - no possible cases to add *-ся* (*стогнати*), « $\text{сґя}-\text{сґя}$ » - possible to use form including a *-ся* or excluding *сґя* (*купати – купатися*).

II. For suffixes of participles:

- (1) Grammatical conjunction (I/II/I-II), where (I-II) means that suffix could be included to both grammatical conjunctions (*втомлений, засохлий, промоклий, мерзлий, опалий, змарнілий, розчервонілий, намерзлий, зажурений, усміхнений*);
- (2) State (active/passive = act/pas);
- (3) Time (present/past = act/pas);
- (4) Kind (perfective/imperfective = d/d);

III. Participles endings forms (full/reduced = f/f). Table. 3 shows a list of morphemes of all the classes listed, indicating the required characteristics.

Table 3. List of morphemes of all classes with a set of characteristics

Class	Example	
I	<i>автоматиз-</i> ($t-\bar{t}, d-\bar{d}, I, \text{atem}, y, \text{сґя}-\text{сґя}$)	<i>побуд-</i> ($t, d, I, \text{atem}, y, \text{сґя}-\text{сґя}$)
	<i>буд-</i> ($t-\bar{t}, d-\bar{d}, I, \text{atem}, y, \text{сґя}-\text{сґя}$)	<i>поділ-</i> ($t, d, II, \text{ґ}, \emptyset, \text{сґя}-\text{сґя}$)
	<i>веч-</i> ($t-\bar{t}, \bar{d}, I, \text{atem}, \emptyset, \text{сґя}-\text{сґя}$)	<i>привес-</i> ($t, d, I, \text{atem}, \emptyset, \text{сґя}-\text{сґя}$)
	<i>втрач-</i> ($t, d-\bar{d}, II, \text{ґ}, \emptyset, \text{сґя}$)	<i>розфарб-</i> ($t, d, I, \text{atem}, y, \text{сґя}-\text{сґя}$)
	<i>втруч-</i> ($\bar{t}, \bar{d}, I, a, \emptyset, \text{сґя}$)	<i>сміј-</i> ($\bar{t}, \bar{d}, I, \text{ґ}, \emptyset, \text{сґя}$)
	<i>дослідж-</i> ($t, d-\bar{d}, I, \text{ґ}, \text{ґ}, \text{сґя}-\text{сґя}$)	<i>спит-</i> ($t, \bar{d}, I, a, \emptyset, \text{сґя}-\text{сґя}$)
	<i>запізн-</i> ($\bar{t}, d, I, \text{ґ}, \text{ґ}, \text{сґя}$)	<i>стогн-</i> ($\bar{t}, \bar{d}, I, \text{ґ}, \emptyset, \text{сґя}$)
	<i>кох-</i> ($t, \bar{d}, I, a, \emptyset, \text{сґя}-\text{сґя}$)	<i>усміх-</i> ($\bar{t}, d, I, \text{atem}, n, \text{сґя}$)

Class	Example
	$люб-(t, \bar{d}, \text{II}, \emptyset, \overline{c\bar{y}})$ $фарб-(t, \bar{d}, \text{I}, atem, y, \overline{c\bar{y}})$
	$мал'-(t-\bar{t}, d-\bar{d}, \text{I}, atem, y, \overline{c\bar{y}})$ $мол-(t, d, \text{I}, o, \emptyset, \overline{c\bar{y}})$
	$нес-(t, \bar{d}, \text{I}, atem, \emptyset, \overline{c\bar{y}})$ $змарн-(\bar{t}, d, \text{I}, i, \emptyset, \overline{c\bar{y}})$
II	$-u(i)-$ $-a(\bar{y})-$ $-y(yo)va-$ $-ovuva-$ $-nu-$
III	$-uva-(-yova-)/-ovuva-/-nu-$
IV	$-л-$ (I-II, <i>act</i> , <i>past</i> , d) $-m-$ (I-II, <i>pas</i> , <i>pres/past</i> , d/\bar{d})
	$-уч-/-юч-$ (I, <i>act</i> , <i>pres</i> , \bar{d}) $-e(\epsilon)n-$ (I-II, <i>pas</i> , <i>pres/past</i> , d/\bar{d})
	$-ач-/-яч-$ (II, <i>act</i> , <i>pres</i> , \bar{d}) $-н-$ (I-II, <i>pas</i> , <i>pres/past</i> , d/\bar{d})
	$-uva-(-yova-)/-ovuva-/-ова-$ (I-II, <i>pas</i> , <i>pres/past</i> , d/\bar{d})
V	f : $-u\ddot{i}$ $-ozo$ $-o\ddot{y}$ $-o\ddot{i}$ $-um$ $-umi$ $-omu$ $-ux$
	\bar{f} : $-a$ $-e$ $-i$ $-y$ $-o$

Now, the rules for creating the forms for Ukrainian participles would be defined [5].

IV. Basic rules

- (1) The wordform must contain no more than one morpheme of each class.
- (2) Morphemes should follow one another in order of class numbering.
- (3) Class 1, 4, 5 morphemes (*base + participle suffix + flexion*) must be present.

V. Incompatibility rules. A wordform cannot contain following items at the same time:

- (1) Morphemes of classes 2 and 3 (thematic element and suffix).
- (2) The word stem with signs $a/i/o$ and the suffix of the participle with the sign *act*.
- (3) The word stem with the sign $\overline{c\bar{y}}$ and ending *-c\bar{y}*.
- (4) The word stem with the sign d in the absence of the suffix for the formation of verb forms and the suffix of the participle with the sign *pres* (from verbs of the completed form, the participles of the present tense are impossible).
- (5) The word stem with the sign \emptyset and the suffix for the formation of verbs.
- (6) The word stem with the sign I and without sign *atem* and the suffix of the participle with the sign II (conjugations of verbs do not allow conjugations of suffixes).
- (7) The word stem with the sign *atem* and adjective suffix with a sign II is different from $-ач-/-яч-$ (non-thematic verbs do not allow suffixes of conjunction, except $-ач-/-яч-$).
- (8) The suffix for the formation of verb forms and the suffix of the participle with the sign II (the suffix for the formation of verbs changes any verb in the conjugation I).
- (9) The word stem with the sign II in the absence of the suffix for the formation of verb forms and the suffix of the participle with the sign I.

- (10) The suffix with the sign *act* and flexion with the sign $\bar{f} = o$ (The unchanging form of the verb is formed from passive participles by replacing the ending with $\bar{f} = o$, for example, *написаний* – *написано*, *забитий* – *забито*, *зроблений* – *зроблено*, *розглянутий* – *розглянуто*).
- (11) The word stem with the sign *atem* (in accordance without the sign *atem*) and suffix *-юч-/-яч-* (in accordance *-уч-/-ач-*), for example, *співаю(ть)* – *співаючий*, *квітну(ть)* – *квітнучий*, *зітхаю(ть)* – *зітхаючий*, *лежа(ть)* – *лежачий*. These forms are of limited use in modern Ukrainian language.
- (12) The word stem with the sign $\% , \%$, or *o*, thematic element and the suffix beginning with a vowel (if the subject element is optional for word stem, it is not used before the suffix beginning with the vowel).
- (13) The word stem with the sign $\% (i, i)$ (in accordance with sign $\% (i, i)$) and the thematic element that is different from *-u(i, i)*- (in accordance from *-a-/-я-*).
- (14) The suffix for the formation of verbs of the perfect and imperfect kind of predominantly foreign origin and the suffix of the participle with signs *act* for example, *атакувати* – *атакований*, *воєнізувати* – *воєнізований*, *гарантувати* – *гарантований*, *інтенсифікувати* – *інтенсифікований*, *наслідувати* – *наслідуваний*, *організовувати* – *організований*, *організувати* – *організований*, *телеграфувати* – *телеграфований*, *телефонувати* – *телефонований*, *яровизувати* – *яровизований*, *засохнути* – *засохлий*, *промокнути* – *промоклий*.
- (15) Participle suffix and ending *-ся* (participles can't have an ending *-ся*).

VI. Rules of inseparability. A wordform must contain following items:

- (1) For word stem with the sign *a* – thematic element *-a-/-я-*.
- (2) For word stem with the sign *i* – thematic element *-u(i, i)*-.
- (3) For word stem with the sign *o* – thematic element *-ор(л)о-* and a possibility for the formation of parallel forms of participles for infinitive verbs (*колоти* – *колотий* and *колений*, *пороти* – *поротий* and *порений*, *молоти* – *молотий* and *мелений*).
- (4) For the infinitive word stem with the sign *-a (-я)*, *-ува- (-юва-)*, *-овува-*, suffix *н-* (*-ий, -а, -е, -і*) is being added, for example *загоювати* – *загоюваний*, *посія(ти)* – *посяний*, *чита(ти)* – *читаний*, *писа(ти)* – *писаний*, *зігна(ти)* – *зігнений*; *розпиля(ти)* – *розпиляний*, *оспівувати* – *оспівуваний*, *застосовувати* – *застосовуваний*; suffix *-ува- (-юва-)* it changes to *-ова-*, if the stress goes to the first vowel, for example *сформулюва(ти)* – *сформульований*, *реконструюва(ти)* – *реконструйований*, *роздрукува(ти)* – *роздрукований*, *запрограмува(ти)* – *запрограмований*.

VII. For word stem with the sign *atem* and the suffix of the participle beginning with a consonant – or a thematic element, or a suffix for the formation of verbs of the perfect and imperfect kind of predominantly foreign origin.

VIII. For word stem with the sign *ся* – the absence of a part *ся* in participles.

IX. Morphological and phonological rules. Morphological rules are rules that relate to phonemic sequences (in our case, phonemes for simplicity are identified with letters), and it is necessary to take into account the morphological role of these se-

quences. Phonological rules deal simply with phonemic sequences, regardless of their morphological status. For the following set of rules the phonological rule is only rule IV.18.

- (1) Between two neighboring vowels belonging to different morphemes, appears *j*, for example *j*, *розділ' + а + јуч + ий*, or *носіј + а + н + ий*, *розпил' + а + н + ий*.
- (2) In the word stem that contains suffix *-ува-* (*-юва-*) and the stress goes to the first vowel, suffix changes on *-ова-*, for example *сформулюва(ти) – сформульованийий, реконструюва(ти) – реконструйованийий, роздрукува(ти) – роздрукованийий, запрограмува(ти) – запрограмованийий*.
- (3) If the word stem of the infinitive ends with vowels *-и, -і (-ї)* or consonants, then the suffix *-ен-* (*-єн-*) is formative; in this case the final vowels fall out, and the consonants are mostly changed, for example, *втрат-и-ти → втрач-єн-ий*.
- (4) All verbs containing *-отіти* of the conjugation I, that have correspondences - *отати* (*цокотіти – цокотять, ор цокотати – цокочуть*): *булькотіти, муркотіти, тріскотати* etc. Some verbs with the word stem *-отати* don't have the correspondences containing *-отіти*, for example *мурм-ота-ти → мурм-оч-у, мурм-оч-уть, бельк-ота-ти → бельк-оч-у, бельк-оч-уть*. In order to describe unregistered cases of type *бельк-ота-ти* (alternation of *i/a* is impossible) or *цокотіти – цокотати* (alternation *i/a* is possible, but not required), it is necessary to enter one more sign of the word stem: alternation of *i/a* before *-ти* is possible / impossible / required.
- (5) In the word stem of verbs with a suffix *-ну-* when changing the kind, this suffix is not saved, for example, *стукнути (d , What to do?) – стукати (d̄ , What shall I do?)*, *крикнути (d , What to do?) – кричати (d̄ , What shall I do?)*. The suffix *-ну-* when the participles are formed also usually falls out, for example *засохну(ти) – засохлий, промокну(ти) – промоклий*.
- (6) In passive participles, *-н-* does not double, for example *зроблений, намальованийий, зав'язанийий, натхнений* тощо.
- (7) If the infinitive word stem ends with vowels *-и, -і (-ї)* or consonants, and the suffix *-єн-* (*-єн-*) is formative, then the final vowels fall out, and the consonants are mostly changed, for example *узгодити – узгодженийий, змусити – змушенийий, запрягти – запряженийий, пекти – печенийий, вразити – враженийий, вертіти – верченийий, пустити – пущенийий, заспокоїти – заспокоєнийий, загоїти – загоєнийий*. For these suffixes, after the labials, *-л-* appears, for example *вловити – вловленийий, купити – купленийий, зробити – зробленийий, зломити – зломленийий*.
- (8) In the formation of participles, in some cases there is an alternation of the consonants in the personal forms given in table 4.

Table 4. Rules for alternating consonants in personal forms

Conjugation	Rule	Example
I	the consonants change at the end of the word stem when the participle is formed, if there is an alternation in	<i>хотіти – хочу, могли – можу, пекти – печу, мазати – мажу, колахати – колишу, чесати –</i>

Conjugation	Rule	Example
	the 1st person singular – <i>з-ж, з-ж, к-ч, х-ш, с-ш, т-ч, ст-ц, ск-ц</i>	<i>чешу, засвістати – засвищу, полоскати – полощу, for example, пекти – печу – печений;</i>
II	sound changes are only in the 1st person singular – <i>д-дж, т-ч, з-ж, с-ш, зд-ждж, ст-ц</i>	<i>просити – прощу, водити – воджу, возити – вожу, їздити – їжджу, треміти – тремчу, мостити – мощу, for example, мостити – моцений. The only exception is the verb бігти (and its derivatives: бігти, перебігти, забігти etc), in which з alternates with the same in all personal forms, for example: бігти – біжу, біжиш, біжить, біжать (вибігти – вибіжу, вибіжиш etc).</i>

(9) In word-alteration and word-formation in verb forms *з-ж, к-ч, х-ш*, for example *берегти – бережу – бережений, стерегти – стережу – стережений*.

(10) In word-alteration and word-formation, in the roots of the verbs given in Table 5.

Table 5. Rules for alternating consonants in the root of the verb

N	Rule	Example
1	<i>д-дж</i>	<i>городити – огороджувати – огороджений; городити – загородити – загороджений;</i>
2	<i>зд-ждж</i>	<i>їздити – їжджу – їжджений;</i>
3	<i>з-ж</i>	<i>возити – вожу, вивожу – вивезений, лазити – лажу;</i>
4	<i>с-ш</i>	<i>висіти – вишу, вивішувати – вивішений;</i>
5	<i>ст-ц</i>	<i>розмістити – розміщу, розмістити – розміщувати – розміщений, мастити – мащу, намащую – намащений, мостити – мощу, замащую – замащений;</i>
6	<i>б-бл</i>	<i>любити – люблю – люблений, полюбляти – полюблений, улюблений, робити – роблю, роблений, виробляю – вироблений;</i>
7	<i>т-ч</i>	<i>летіти – летчу, платити – плачу, сплачувати – сплачений, крутити – кручу – кручений, накручую – накручений; платити – сплатити – сплачений;</i>
8	<i>п-пл</i>	<i>терпіти – терплю – терплячий;</i>
9	<i>м-мл</i>	<i>громити – громлю – погромити – погромлений;</i>
10	<i>ф-фл</i>	<i>графити – графлю – графлений, розграфлювати;</i>
11	<i>т-д</i>	<i>вести – водити, виводити – виведений;</i>
12	<i>в-вл</i>	<i>ловити – ловлю, виловлювати – виловлений.</i>

(11) In some cases the element *-ва-* is lost, depending on the tense of the verb, for example *купувати – купити, вбивати – вбити, or друкувати – надрукувати, співати – проспівати*.

- (12) In a word form that has the suffix *-y(yo)va-*, or the word stem has an ending *u/a* the root vowel is in some cases replaced by *a*. To describe the type cases that are not included here *заспокоїти – заспокоювати* and *заспокоєний – заспокоюваний* (alteration of the *o/a* is impossible) or *ломити – ламати* and *ломлений – ламаний* (alteration of the *o/a* is possible, but not required), another word stem sign is needed – alteration of *o/a* before *-y(yo)va-* is possible/impossible/required. The alternation in the root of the verb occurs for vowels given in Table 6-8.

Table 6. The rules of alternation at the root of verbs for the vowels *o* and *a*

N	Rule	Example
1	with <i>o</i> long, undivided action or a single, complete, complete appearance	<i>гонити – гонений; схопити – схоплений; котити – кочений; клонити – клонений; кроїти; ломити; допомогти; скочити; виняток – вимовити; простити; заспокоїти; установити;</i>
2	with <i>a</i> - repeated, multiple action, imperfect appearance	<i>ганяти – ганяючий; хапати – хапаючий; катати – катаючий; кланятися; краяти – краючий; ламати – ламаючий; допомагати; скакати – скакаючий; виняток – вимовляти; прощати; заспокоювати; установлювати.</i>

Table 7. The rules of alternation at the root of the verbs for the vowels *e* (unalterable) and *i*

N	Rule	Example
1	with <i>e</i> in prefixed verbs of the perfective aspect	<i>вигребти; замести; випекти; наректи; зберегти; викоренити; причепити</i>
2	with <i>i</i> in prefixed verbs of the imperfective aspect	<i>вигрібати; замітати; випікати; нарікати; зберігати; викорінювати; причіпляти й зачіпати;</i>
3	in verbs with suffix <i>-yva-</i> (<i>-юва-</i>) containing stress at root <i>i</i> and in the nouns derived from these verbs ending with <i>-ння</i>	<i>брехати – набріхувати – набріхування, завертіти – завірчувати – завірчування, чекати – очікувати – очікування, полоскати – виполіскувати – виполіскування, але: вивершувати – вивершування, потребувати – потребування, прищеплювати – прищеплювання.</i>

Table 8. The rules of alternation in the root of verbs for vowels *e* (alterable) and *u* before *л, р*

N	Rule	Example
1	with <i>e</i> in the roots of verbs	<i>вистелю – вислати – висланий – вистеляючий, беру – брати – вибраний – вибираючий, завмер – замру – завмираючий, стер – стертий – стираючий, умерти – умру – умираючий;</i>
2	with <i>u</i> in the roots of verbs	<i>вибирати – вибраний – вибираючий, завмирати – завмираючий, стирати – стертий – стираючий, умирати – умираючий.</i>

- (13) The participle suffixes are not doubled because the stress in the parcsiples falls to the root (Table 9).

Table 9. Rules for the use of participle suffixes in the creation of participle

N	Rule	Example
1	-ан(ий)	завішаний, сказаний, вихований
2	-ен(ий)	неоцінений, нескінчений, незлічений, завішений, куплений
3	-ян(ий)	порівняний

(14) Rules for the use of verb suffixes are given in Table. 10.

Table 10. Rules for the use of verb suffixes in the formation of participles

Emphasis	Suffixes	Example
in roots in derivative words and forms (nouns and participles derived from verbs)	-ува-	бомбувати – бомбування, марширувати – марширування, вивершувати – вивершування – вивершуваний, маркувати – маркування, очікувати – очікування – очікуваний;
to the first suffix vowel	-юва-	підбілювати – підбілювання – підбілюваний;
	-ова-	мальований, <i>ог</i> малювати, малювання; <i>риштований</i> , <i>риштовання</i> , <i>ог</i> <i>риштувати</i> , <i>риштування</i> ; <i>друкований</i> , <i>ог</i> <i>друкувати</i> , <i>друкування</i> ; <i>підпорядкований</i> , <i>ог</i> <i>підпорядкувати</i> , <i>підпорядкування</i> ;
	-овува-	завойовувати – завойовування – завойований; <i>перемальовувати</i> – <i>перемальовування</i> – <i>перемальований</i> .

(15) Before the suffixes -е(є)н-, -у(ю)ва-, -ова-, -овува- the final consonant of the word stem -с'- is replaced with -ш-, and the final consonant -б'- with -бл'- (similarly, д'-ж, т'-ч, в'-вл etc.; but in our list there are no word stems for -д'-, -т'-, -в'-), for example, *вистити* – *вишу*, *вивішувати* – *вивішений*; *любити* – *люблю* – *люблений*, *полюбляти* – *полюблений*, *улюблений*, *робити* – *роблю*, *роблений*, *виробляю* – *вироблений*.

(16) Before suffixes -е(є)н-, -у(ю)ва-, -ова-, -овува- the solid ending of consonants of the word stems are softened by: д-д', с-с', etc.

(17) The unchanging form of the verb is formed from passive participles by replacing the ending with a suffix -о, for example, *написаний* – *написано*, *забитий* – *забито*, *зроблений* – *зроблено*, *розглянутий* – *розглянуто*. Form with -но, -то should be used instead of passive participles when it is necessary to emphasize actions rather than signs, for example, *урок закінчено*, *книжки здано*.

(18) The combination of *ju* is replaced by and *i*.

X. Graphic- orthography rules:

(1) The combination of *ja, ju, je, ji* are depicted as *я, ю, є, ї*.

(2) The combination *X'a, X'у, X'e, X'i, X'u* are depicted as *Xя, Xю, Xє, Xї, Xi* (*X'* – any of the paired soft consonants).

Note. There is a difficulty of the formation of passive participles of the past tense from the word stem of the imperfect kind without suffixes. In some cases, they are possible (*писаний, фарбований*), in others, perhaps impossible (*зублений*); there are many intermediate, not entirely clear cases, such as *ведений, люблений, будований*.

The context here, which is not taken into account in the rules laid down, is crucial here, and therefore such entities, formally always possible, are allowed by these rules (and are generated by the grammar constructed on the basis of these rules).

Thus, we have drawn up precise rules that describe the set of word forms we need - forms of adjectives of several Ukrainian verbs [5]. We use the data obtained to construct generative grammar.

Generative grammar $G = (V, T, S, P)$ is a system that contains an alphabet – set V , and its subset T of terminal elements, starting symbol $S (S \in V)$ and a set of products P . Set V/T is depicted as N . Elements from N are called non-terminal. Every product from P should contain at least one non-terminal element in the left part.

- (1) **A set of terminal symbols** – a selection of initial elements that make up the grammar-generated chains. In grammar G_0 - it is a set of all Ukrainian letters, which are typed in italics unlike other uses of these letters. Thus, real Ukrainian morphemes and word forms will be written in italics. Morphemes, as such, are not considered to be independent characters and are therefore not included in the set of terminal characters or in the set of non-terminal characters (see below, paragraph 2): they are considered as chains of terminal characters - letters. A plurality of terminal symbols (for example, class 1 morphemes in the example just sorted out) are essentially Group VIII rules.
- (2) **A set of non-terminal symbols** - a selection of characters that denote the classes of terminal elements or chains of terminal elements, as well as, in some cases, some special elements. In the grammar we introduce the following non-terminal characters, presented in table 11.

Table 11. Non-terminal symbols of grammar G_0

N	Symbol	Explanation
1	D_K	participle;
2	$D_K(x, y)$	participle of a given state and time (value for x, y listed below, rule I);
3	$O'(a_1, a_2, a_3, a_4, a_5, a_6)$	the base of the verb, including the suffix or thematic element, if any, and supporting information for it: a_1 – transistence ($t/\bar{t}/t-\bar{t}$); a_2 – kind ($d/\bar{d}/d-\bar{d}$); a_3 – conjugation (I/II); a_4 – thematic ($a/i/\bar{a}/\bar{a}o/atem$); a_5 – possibility of suffix ($y/\bar{y}H/\bar{y}$), a_6 – possibility or need of accession $-c\bar{y}$ ($c\bar{y}/\bar{c}\bar{y}/c\bar{y}-\bar{c}\bar{y}$);
4	$O(a_1, a_2, a_3, a_4, a_5)$	"Pure" participle basis (without possibility or necessity accession $-c\bar{y}$ ($c\bar{y}/\bar{c}\bar{y}/c\bar{y}-\bar{c}\bar{y}$))with the same supporting information as above;
5	$C(x, y, a_3)$	the suffix of the participle with the information to it (x – state, y – time, a_3 – conjugation, see: above);

N	Symbol	Explanation
6	$\Phi(u, r, n)$	Flexion of the participle with information to it; u – form (full / abbreviated = f / \bar{f}), r – gender category (male / female / medium = $m / w / k$), n – number (singular / plural = s / \bar{s}).

O , C , Φ – morphemes without information; C_d – suffix of the verb; T – thematic element; + – the boundary between morphemes; automatically appears after those morphemes that word forms cannot end; X' – soft consonant, where X – the depiction of an arbitrary consonant; j – the depiction of sound [j] (*yot*).

(3) **Starting symbol** – a non-terminal symbol identifying the set (class) of all those linguistic objects for which the grammar is assigned. In grammar G_0 , this is a D_K symbol, because our purpose is to describe the set of participles.

(4) **A set of products (substitution rules)** – equation like $X \rightarrow Y$ (change X for Y or change X for Y), where X and Y – chains, that include different terminal or non-terminal symbols. In grammar G_0 the rules of substitution are following:

I. Defining the grammatical meanings of a participle. For a better understanding, the substitution rules are divided into groups (numbered in Roman numerals), each of which corresponds to a specific meaningful representation; this view is indicated by the group number. Group and rule numbers should not be construed as indicating the order in which they are applied: the order in which the rules of the generating grammar are applied is arbitrary.

$$D_K \rightarrow D_K(x, y), \text{ where } x = (act / pas); \quad y = (pres / past);$$

Expression $D_K \rightarrow D_K(x, y)$ is used for reduction: in fact, there are not one but four rules corresponding to the valid sets of variable values x , y , for example $D_K \rightarrow D_K(act, pres)$ then $D_K \rightarrow D_K(pas, pres)$ and so on. In the other cases x , y , are used in the same way.

II. Implementation of grammatical values by corresponding morphemes. As mentioned above, real Ukrainian morphemes and word forms are typed in italics.

$$(1) \quad D_K(act, pres) \rightarrow O'(t, \bar{d}, a_3)C(act, pres, a_3)\Phi$$

$$(2) \quad 2. \quad D_K(act, past) \rightarrow O'(\bar{t}, d, a_3)C(act, past, a_3)\Phi$$

$$(3) \quad 3. \quad D_K(pas, pres) \rightarrow O'(t, d - \bar{d}, a_3)C(pas, pres, a_3)\Phi$$

$$(4) \quad 4. \quad D_K(pas, past) \rightarrow O'(t, d - \bar{d}, a_3)C(pas, past, a_3)\Phi$$

When writing information to morphemes for reduction, the designations of those features which in this rule can acquire any values. So, for example, expression $O(\bar{d}, a_3)$ is a reduction for many expressions like $O(a_1, \bar{d}, a_3, a_4, a_5)$, where (a_1, a_3, a_4, a_5) ac-

quire any valid values; accordingly expression $C(act, past)$ also reductions for two expressions like $C(act, past, a_3)$. Therefore, for example, line II.1 actually contains not more than one rule, but many more different rules.

III. Decomposition of the "difficult" word stem (the selection of the actual word stem and the thematic element or suffix, if any). Here \overline{atem} is used for reduction and stands for any meaning of the sign a_4 , different from $atem$, meaning $(a/i/\emptyset/\emptyset/o)$. A similar meaning has the expression $\overline{\emptyset}$.

- (1) $O'(\overline{atem}) \rightarrow O(\overline{atem})T$
- (2) $O'(\overline{d}, \overline{\emptyset})C(x, y) \rightarrow O(\overline{d}, \overline{\emptyset})C_d C(x, y, I)$

In this rule, variables x i y must satisfy the following condition: if $x = pas$ it is necessary that $y = pres$.

- (3) $O'(atem) \rightarrow O(atem)$

IV. Implementation of the thematic element of the corresponding morpheme.

- (1) $O(\emptyset)T\alpha \rightarrow O(\emptyset)\alpha$
- (2) $O(\emptyset)T\alpha \rightarrow O(\emptyset)\alpha$
- (3) $O(a)T \rightarrow O(a)a +$
- (4) $O(i)T \rightarrow O(i)i +$
- (5) $O(o)T \rightarrow O(o)o +$
- (6) $O(\overline{d}, II, a)TC(act, pres) \rightarrow O(\overline{d}, II, a)a + C(act, pres)$
- (7) $O(d - \overline{d}, I, a)TC(pas, pres) \rightarrow O(d - \overline{d}, I, a)a + C(pas, pres)$
- (8) $O(d - \overline{d}, I, i)TC(pas, pres) \rightarrow O(d - \overline{d}, I, i)a + C(pas, pres)$
- (9) $O(\emptyset)T\beta \rightarrow O(\emptyset)\beta$
- (10) $O(\emptyset)T\beta \rightarrow O(\emptyset)\beta$

Here α and β - reducing; α - arbitrary vowel, β - arbitrary consonant.

V. Implementation of a suffix for verb formation by a corresponding morpheme.

- (1) $C(act, past, I - II) \rightarrow \lambda +$
- (2) $O(atem)C(act, pres, I) \rightarrow y\lambda +$
- (3) $O(\overline{atem})YC(act, pres, I) \rightarrow \lambda y +$
- (4) $O(atem)C(act, pres, II) \rightarrow a\lambda +$
- (5) $O(\overline{atem})YC(act, pres, II) \rightarrow \lambda a +$
- (6) $C(pas, pres / past, I - II) \rightarrow h +$

- (7) $C(pas, pres / past, I - II) \rightarrow m +$
 (8) $O(atem)C(pas, pres / past, I - II) \rightarrow eH +$
 (9) $O(\overline{atem})YC(pas, pres / past, I - II) \rightarrow eH +$
 (10) $O(atem)C(pas, pres / past, I - II) \rightarrow yBa +$
 (11) $O(\overline{atem})YC(pas, pres / past, I - II) \rightarrow yBa +$
 (12) $C(pas, pres / past, I - II) \rightarrow oByBa +$
 (13) $O(atem)C(pas, pres / past, I - II) \rightarrow oBa +$
 (14) $O(\overline{atem})YC(pas, pres / past, I - II) \rightarrow yova +$
 (15) $O(\overline{atem})XC(pas, pres / past, I - II) \rightarrow X'ova +$

Here Y - reducing; arbitrary suffix or thematic element.

VI. The choice of the form of the participle (f / \bar{f}) and the implementation of flexion by the corresponding morpheme.

- | | |
|---|---|
| 1) $\Phi \rightarrow \Phi(f)$ | 6) $\Phi \rightarrow \Phi(\bar{f})$ |
| 2) $\Phi(f, s) \rightarrow ozo, um, omu$ | 7) $\Phi(\bar{f}, w) \rightarrow a, y$ |
| 3) $\Phi(f, m) \rightarrow u\ddot{i}$ | 8) $\Phi(\bar{f}, k) \rightarrow e$ |
| 4) $\Phi(f, w) \rightarrow oyo, oi$ | 9) $\Phi(\bar{f}, \bar{s}) \rightarrow i$ |
| 5) $\Phi(f, \bar{s}) \rightarrow um, umi, ux$ | 10) $C(pas)\Phi(\bar{f}) \rightarrow o$ |

VII. The implementation of the word stem of the corresponding morpheme. Group VIII rules are not numbered because each line here is a whole set of rules whose number is determined by the number of bases with this information.

- (1) $O(t - \bar{t}, d - \bar{d}, I, atem, y) \rightarrow avtomatiz+, bud+, mal'+, \dots$
 (2) $O(t - \bar{t}, \bar{d}, I, atem, \emptyset) \rightarrow ves+, \dots$
 (3) $O(t, d - \bar{d}, II, \emptyset) \rightarrow vtrach+, \dots$
 (4) $O(\bar{t}, \bar{d}, I, a, \emptyset) \rightarrow vtruch+, \dots$
 (5) $O(t, d - \bar{d}, I, \emptyset) \rightarrow doslidzh+, \dots$
 (6) $O(\bar{t}, d, I, \emptyset) \rightarrow zapizn+, \dots$
 (7) $O(t, \bar{d}, I, a, \emptyset) \rightarrow kox+, \dots$
 (8) $O(t, \bar{d}, II, \emptyset) \rightarrow lyob+, \dots$
 (9) $O(t, \bar{d}, I, atem, \emptyset) \rightarrow nes+, \dots$

- (10) $O(t, d, I, atem, y) \rightarrow побуд+, розфарб+, \dots$
 (11) $O(t, d, II, \emptyset) \rightarrow поділ+, \dots$
 (12) $O(t, d, I, atem, \emptyset) \rightarrow привес+, \dots$
 (13) $O(\bar{t}, \bar{d}, I, \emptyset) \rightarrow сміj+, стогн+, \dots$
 (14) $O(t, \bar{d}, I, a, \emptyset) \rightarrow спит+, \dots$
 (15) $O(\bar{t}, d, I, atem, н) \rightarrow усміх+, \dots$
 (16) $O(t, \bar{d}, I, atem, y) \rightarrow фарб+, \dots$
 (17) $O(t, d, I, o, \emptyset) \rightarrow мол+, \dots$
 (18) $O(\bar{t}, d, I, i, \emptyset) \rightarrow змарн+, \dots$

VIII. Morphological rules.

- (1) $\alpha_1+ \rightarrow \alpha_1 + j\alpha_2$ (where α_1 and α_2 are arbitrary vowels).
 (2) $j+u \rightarrow i$.
 (3) $oX + C(pas, pres) + \Phi \rightarrow aX + C(act, pres) + \Phi$.

Here X reduced string not exceeding three characters. It is about alternating o/a in the verb root of the type of *гонити/ганяти*, *схопити/хапати*, *котити/катати*, *клонити/кланятися*, *кроїти/краяти*, *ломити/ламати*, *скочитити/скакати*, *допомогти/допомагати*. The consonant group, which appears to be rooted in that it alternates -o- (i.e., which separates it from the thematic element -a/-я- before -y(yo)va- does not appear to contain more than three letters.

4. $c' + X \rightarrow u + X$ $v' + X \rightarrow vl' + X$
 $\bar{b}' + X \rightarrow \bar{b}l' + X$
 $\partial' + X \rightarrow \partial ж' + X$ Тут $X = -e(\epsilon)n-$, $-y(yo)va-$, $-ова-$, $-овува-$.

Before suffixes $-e(\epsilon)n-$, $-y(yo)va-$, $-ова-$, $-овува-$ the ending consonant of the word stem $-c'$ alternates for $-u-$, and the ending consonant $-\bar{b}'$ for $-\bar{b}l'$ (same for ∂' -ж, m' -ч, v' -вл, etc; but in our list there is no word stems with $-\partial'$, $-m'$, $-v'$).

5. $\partial + X$ $\partial' + X$; $c + X$ $c' + X$; ... Before suffixe X ($-e(\epsilon)n-$, $-y(yo)va-$, $-ова-$, $-овува-$) the solid ending of consonants of the foundations are softened by: ∂ - ∂' , c - c' , etc.; *принес + ти* – *принес' + ен + ий*.

6. $нн + \Phi$ $н + о$.

IX. X. Graphic-orthographic rules.

- | | |
|-------------------------------|----------------------------|
| 1. $j + a \rightarrow я$ | $ja \rightarrow я$ |
| $j + y \rightarrow ю$ | $ju \rightarrow ю$ |
| $j + e \rightarrow є$ | $je \rightarrow є$ |
| | |
| 2. $X' + a \rightarrow X + я$ | |
| $X' + y \rightarrow X + ю$ | $X' + u \rightarrow X + i$ |
| $X' + e \rightarrow X + є$ | $X' + i \rightarrow X + і$ |

Here X – arbitrary consonant.

X. Erasure of boundary between morphemes.

$$X + Y \rightarrow XY$$

Here X and Y are any morphemes that none of the rules of groups IX-X apply.

This restriction on X and Y prevents the boundary between morphemes being erased very early, before applying the relevant morphological rules. Otherwise, such morphological rules would not be applied, which would lead to incorrect results (for example, * *качений* from *катати* or **котающий* from *котити*) the fact is that if any morphological rule can be applied, then it must be applied.

So, introducing example G_0 , we have described the composition of formal generative grammar. We introduce several concepts necessary to describe the use of grammar, that is, to describe the process of generation [1, 2].

Immediate deductibility. If there are two chains X and Y , $X = Z_1AZ_2$ and $Y = Z_1BZ_2$ (Z_1 and / or Z_2 can be empty) and there is a rule $A \rightarrow B$ in grammar G , then it is directly deduced in G from X [2]. In other words, X can be redone in Y in one step - using a single substitution: Y turns out from X to be a substitution B for some entry of the chain A . For example, from a chain

$$O(t, \bar{d}, I, a, \emptyset, \overline{c\bar{y}})a + C(I, act, pres, \bar{d}) + \Phi$$

according to rule VI.3, the chain is output directly

$$O(t, \bar{d}, I, a, \emptyset, \overline{c\bar{y}})a + \text{юч} + \Phi$$

Deductibility. If there is a sequence of chains X_0, X_1, \dots, X_n in which each successive chain is directly derived from the previous one, then X_n is output from X_0 ; the same sequence X_0, X_1, \dots, X_n is called output X_n from X_0 [2]. This means that X_0 does not necessarily translate into X_n in one step, but through the consistent use of several substitutions. Obviously, direct inference is a separate case of inference. Here is an example of output in the presented grammar G_0 (in parentheses, to the left of the output line, specifies the rule number, the application of which to the previous line gives this).

D_κ

(I) $D_\kappa(pas, pres)$

(II.3) $O'(t, d, I, atem, y, \overline{c\bar{y}})C(pas, pres, I)\Phi$

(III.3) $O(t, d, I, atem, y)C(pas, pres, I)\Phi$

(VI.13) $O(t, d, I, atem, y)ова + \Phi$

(VII.1) $O(t, d, I, atem, y)ова + \Phi(f)$

(VII.3) $O(t, d, I, atem, y)ова + \text{иӱ}$

(VIII.10) *розфарб* + *ова* + *иӱ*

(XI) *розфарбовавиӱ*

This output (beginning with an initial character and ending with a chain consisting only of terminal characters) is called complete. Of course, not every derivation beginning with an initial character is complete; in particular, such outputs beginning with an initial character that cannot be continued until full output are "deadlocked output".

Here is an example of deadlock in G_0 .

$$\begin{aligned}
 & D_\kappa \\
 \text{(I)} & D_\kappa(act, past) \\
 \text{(II.2)} & O'(\bar{t}, d, II, atem, \emptyset, c\bar{я} - \bar{c}\bar{я})C(act, past, II)\Phi \\
 \text{(III.3)} & O(\bar{t}, d, II, atem, \emptyset)C(act, past, II)\Phi \\
 \text{(VI.1)} & O(\bar{t}, d, II, atem, \emptyset)_л + \Phi \\
 \text{(VII.1)} & O(\bar{t}, d, II, atem, \emptyset)_л + \Phi(f) \\
 \text{(VII.3)} & O(\bar{t}, d, II, atem, \emptyset)_л + u\ddot{u} \\
 \text{(XI)} & O(\bar{t}, d, II, atem, \emptyset)_л u\ddot{u}
 \end{aligned}$$

It is impossible to continue this conclusion, though it is not complete, that is, it does not end with a chain of terminal characters (Ukrainian letters). In grammar G_0 , there is no rule whose left side would be contained in the last chain of this output. This is explained by the fact that in the Ukrainian language there are no athematic verbs (the base ends in the consonant), which are cancelled by the II conjugation. Thus, the signs *atem*, \emptyset and *II*, which were interpreted as independent in constructing the grammar G_0 , are in fact connected. Their coherence could be taken into account, but this would make the grammar more noticeable. Formal grammar does not require at all that any derivation in it ends with a correct

terminal chain: it is sufficient that any complete derivation gives the correct chain (in our case, the form of the Ukrainian participle) [2, 5]. Thus, the language generated by grammar G_0 is the totality of all participles of the above verbs. Obviously, this language is over. However, grammars can also produce endless languages. Thus, the use of grammar is the construction of complete inferences; the last strands of these derivations form a grammar-generated language.

5 Conclusions

To simulate the generation of language and texts at the morphemic level, a linguistic analysis of the set of adjectives was performed, the classes of morphemes involved in the creation of word forms were identified, and the rules for the combination of morphemes with each other were determined. Identified features of word formation can be used to construct systems of computer morphological analysis and synthesis [6]: to create a generative grammar that generates language - a set of all considered adjectives. Application of the theory of generative grammars to solve problems of applied and computational linguistics at the level of morphology allows to create systems of

synthesis of language and texts, as well as to create textbooks of practical morphology, to create tables of words, to list morphemes (affixes, roots), to determine productivity, to determine the frequency of implementation in texts of different grammatical categories (categories of genus, case, number, etc.) for specific languages [6, 7]. Model-based generative grammars can be used to ensure the functioning of computer-based linguistic systems for analytical and synthetic document processing, information retrieval systems, and the like.

References

1. Gladkiy, A.V. Mel'chuk, I. A.: Elementy matematicheskoy lingvistiki. In: Nauka, Moscow (1969)
2. Gladkiy, A.V.: Formal'nyye grammatiki i yazyki. In: Nauka, Moscow (1973)
3. Darchuk, N.P.: Komp'yuterna linhvistyka (avtomatychne opratsyuvannya tekstu). In: Kyiv's'kyi universytet VPTS, Kyiv, Ukraine (2008)
4. Demeshko, I.: Typolohiya morfonolohichnykh modeley u viddiyestivnomu slovotvorenni suchasnoyi ukrayins'koyi movy. In: Zbirnyk naukovykh prats' Linhvistychni studiyi, 19, 162-167. (2009)
5. Zubkov, M.: Ukrayins'ka mova: Universal'nyy dovidnyk. In: VD Shkola, Kyiv, Ukraine (2004)
6. Partyko, Z.V.: Prykladna i komp'yuterna linhvistyka. In: Afisha, Lviv, Ukraine (2008)
7. Rusachenko, N.P.: Morfonolohichni protsesy u slovozhmini ta slovotvori staroukrayins'koyi movy druhoyi polovyny XVI – XVIII st. In: Avtoreferat dysertatsiyi na zdobuttya naukovooho stupenya kandydata filolohichnykh nauk, http://auteur.corneille-moliere.com/?p=history&m=corneille_moliere&l=rus, last accessed 2019/11/21.
8. Potapova, H.M.: Morfonolohiya viddiyestivnoho slovotvorennya (na materialy slovotvirnykh hnidz z vershynamy - diyeslovamy ta viddiyestivnykh slovotvirnykh zon). In: Dys. kand. nauk: 10.02.02, Ukraine (2008).
9. Ukrayins'kyi pravopys. In: In-t movoznavstva im. O.O. Potebni NAN Ukrayiny, In-t ukr. movy NAN Ukrayiny, Nauk. dumka, Kyiv, Ukraine (2007)
10. Chomsky, N.: O nekotornykh formal'nykh svoystvakh grammatik. In: Kiberneticheskyy sbornik, 5, 279-311. (1962)
11. Chomsky, N., Miller, G. A.: Formal'nyy analiz yestestvennykh yazykov. In: Kiberneticheskyy sbornik, 1, 231-290. (1965)
12. Chomsky, N.: Yazyk i myshleniye. In: Publikatsii OSiPL. Seriya monografiy, 2. (1972)
13. Chomsky, N.: Sintaksicheskyye struktury. In: Sbornik Novoye v lingvistike, 2, 412-527. (1962)
14. Babichev, S.: An Evaluation of the Information Technology of Gene Expression Profiles Processing Stability for Different Levels of Noise Components. In: Data, 3 (4), art. no. 48 doi: 10.3390/data3040048 (2018)
15. Babichev, S., Durnyak, B., Pikh, I., Senkivskyy, V.: An Evaluation of the Objective Clustering Inductive Technology Effectiveness Implemented Using Density-Based and Agglomerative Hierarchical Clustering Algorithms. In: Advances in Intelligent Systems and Computing, 1020, 532-553 doi: 10.1007/978-3-030-26474-1_37 (2020)
16. Chomsky, N.: Three models for the description of language. In: I. R. E. Trans. PGIT 2, 113-124. (1956)
17. Chomsky, N.: On certain formal properties of grammars, Information and Control 2. In: A note on phrase structure grammars, Information and Control 2, 137-267, 393-395. (1959)

18. Chomsky, N.: On the notion «Rule of Grammar». In: Proc. Symp. Applied Math., 12. Amer. Math. Soc. (1961)
19. Chomsky, N.: Context-free grammars and pushdown storage. In: Quarterly Progress Reports, 65, Research Laboratory of Electronics, M. I. T. (1962)
20. Chomsky, N.: Formal properties of grammars. In: Handbook of Mathematical-Mathematical Psychology, 2, ch. 12, Wiley, 323-418. (1963)
21. Chomsky, N.: The logical basis for linguistic theory. In: Int. Cong. Linguists, (1962)
22. Chomsky, N., Miller, G. A.: Finite state languages. In: Information and Control 1, 91-112. (1958)
23. Chomsky, N., Miller, G. A.: Introduction to the formal analysis of natural languages. In: Handbook of Mathematical Psychology 2, ch. 12, Wiley, 269-322. (1963)
24. Chomsky, N., Schützenberger M.P.: The algebraic theory of context-free languages. In: Computer programming and formal systems, North-Holland, Amsterdam, 118-161 (1963)
25. Khomytska, I., Teslyuk, V., Holovatyy, A., Morushko, O.: Development of methods, models, and means for the author attribution of a text. In: Eastern-European Journal of Enterprise Technologies, 3(2-93), 41-46. (2018)
26. Khomytska, I., Teslyuk, V.: Authorship and Style Attribution by Statistical Methods of Style Differentiation on the Phonological Level. In: Advances in Intelligent Systems and Computing III. AISC 871, Springer, 105-118, doi: 10.1007/978-3-030-01069-0_8 (2019)
27. Vysotska, V.: Linguistic Analysis of Textual Commercial Content for Information Resources Processing. In: Modern Problems of Radio Engineering, Telecommunications and Computer Science, TCSET'2016, 709-713 (2016)
28. Su, J., Vysotska, V., Sachenko, A., Lytvyn, V., Burov, Y.: Information resources processing using linguistic analysis of textual content. In: Intelligent Data Acquisition and Advanced Computing Systems Technology and Applications, Romania, 573-578, (2017)
29. V. Lytvyn, V. Vysotska, P. Pukach, Z. Nytrebych, I. Demkiv, R. Kovalchuk, N. Huzyk: Development of the linguometric method for automatic identification of the author of text content based on statistical analysis of language diversity coefficients, Eastern-European Journal of Enterprise Technologies, 5(2), 16-28 (2018)
30. Vysotska, V., Lytvyn, V., Hrendus, M., Kubinska, S., Brodyak, O.: Method of textual information authorship analysis based on stylometry, 2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT 2018, 9-16 (2018)
31. Lytvyn, V., Vysotska, V., Pukach, P., Nytrebych, Z., Demkiv, I., Senyk, A., Malanchuk, O., Sachenko, S., Kovalchuk, R., Huzyk, N.: Analysis of the developed quantitative method for automatic attribution of scientific and technical text content written in Ukrainian, Eastern-European Journal of Enterprise Technologies, 6(2-96), pp. 19-31 (2018)
32. Vysotska, V., Burov, Y., Lytvyn, V., Demchuk, A.: Defining Author's Style for Plagiarism Detection in Academic Environment, Proceedings of the 2018 IEEE 2nd International Conference on Data Stream Mining and Processing, DSMP 2018, 128-133 (2018)
33. Vysotska, V., Fernandes, V.B., Lytvyn, V., Emmerich, M., Hrendus, M.: Method for Determining Linguometric Coefficient Dynamics of Ukrainian Text Content Authorship, Advances in Intelligent Systems and Computing, 871, 132-151 (2019)
34. Lytvyn, V., Vysotska, V., Burov, Y., Bobyk, I., Ohirko, O.: The linguometric approach for co-authoring author's style definition, Proceedings of the 2018 IEEE 4th International Symposium on Wireless Systems within the International Conferences on Intelligent Data Acquisition and Advanced Computing Systems, IDAACS-SWS 2018, 29-34 (2018)
35. Vysotska, V., Kanishcheva, O., Hlavcheva, Y.: Authorship Identification of the Scientific Text in Ukrainian with Using the Lingvometry Methods, 2018 IEEE 13th International

Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT 2018 – Proceedings 2, 34-38 (2018)

36. Lytvyn, V., Sharonova, N., Hamon, T., Cherednichenko, O., Grabar, N., Kowalska-Styczen, A., Vysotska, V.: Preface: Computational Linguistics and Intelligent Systems (COLINS-2019). In: CEUR Workshop Proceedings, Vol-2362. (2019)
37. Lytvyn V., Vysotska V., Peleshchak I., Basyuk T., Kovalchuk V., Kubinska S., Chyrun L., Rusyn B., Pohreliuk L., Salo T.: Identifying Textual Content Based on Thematic Analysis of Similar Texts in Big Data. In: 2019 IEEE 14th International Scientific and Technical Conference on Computer Science and Information Nechnologies (CSIT'2019), 84-91. (2019)
38. Vysotska V., Lytvyn V., Kovalchuk V., Kubinska S., Dilai M., Rusyn B., Pohreliuk L., Chyrun L., Chyrun S., Brodyak O.: Method of Similar Textual Content Selection Based on Thematic Information Retrieval. In: 2019 IEEE 14th International Scientific and Technical Conference on Computer Science and Information Nechnologies (CSIT'2019), 1-6. (2019)
39. Cherednichenko, O., Babkova, N., Kanishcheva, O.: Complex Term Identification for Ukrainian Medical Texts. In: CEUR Workshop Proceedings, Vol-2255, 146-154. (2018)
40. Bobicev, V., Kanishcheva, O., Cherednichenko, O.: Sentiment Analysis in the Ukrainian and Russian News. In: First Ukraine Conference on Electrical and Computer Engineering (UKRCON), 1050-1055. (2017)
41. Fedushko, S., Benova, E.: Semantic analysis for information and communication threats detection of online service users. In: The 10th International Conference on Emerging Ubiquitous Systems and Pervasive Networks (EUSPN), 160, 254-259. (2019)
42. Antonyuk N., Chyrun L., Andrunyk V., Vasevych A., Chyrun S., Gozhyj A., Kalinina I., Borzov Y.: Medical News Aggregation and Ranking of Taking into Account the User Needs. In: CEUR Workshop Proceedings, Vol-2362, 369-382. (2019)
43. Chyrun, L., Chyrun, L., Kis, Y., Rybak, L.: Automated Information System for Connection to the Access Point with Encryption WPA2 Enterprise. In: Lecture Notes in Computational Intelligence and Decision Making, 1020, 389-404. (2020)
44. Kis, Y., Chyrun, L., Tsymbaliak, T., Chyrun, L.: Development of System for Managers Relationship Management with Customers. In: Lecture Notes in Computational Intelligence and Decision Making, 1020, 405-421. (2020)
45. Chyrun, L., Burov, Y., Rusyn, B., Pohreliuk, L., Oleshek, O., Gozhyj, A., Bobyk, I.: Web Resource Changes Monitoring System Development. In: CEUR Workshop Proceedings, Vol-2386, 255-273. (2019)
46. Chyrun, L., Gozhyj, A., Yevseyeva, I., Dosyn, D., Tyhonov, V., Zakharchuk, M.: Web Content Monitoring System Development. In: CEUR Workshop Proceedings, Vol-2362, 126-142. (2019)
47. Gozhyj, A., Chyrun, L., Kowalska-Styczen, A., Lozynska, O.: Uniform Method of Operative Content Management in Web Systems. In: CEUR Workshop Proceedings, Vol-2136, 62-77. (2018)
48. Chyrun, L., Kowalska-Styczen, A., Burov, Y., Berko, A., Vasevych, A., Pelekh, I., Ryskovets, Y.: Heterogeneous Data with Agreed Content Aggregation System Development. In: CEUR Workshop Proceedings, Vol-2386, 35-54. (2019)