

The 2-Stage Logical Grammar of Georgian Language And The 1-Stage Voice Managed Georgian Intellectual Computer System

In the paper, mainly, we will discuss the theoretical and technological aims of one year subproject “Foundations of Logical Grammar of Georgian Language and its Methodological and Technological Applications” of State Priority Program (SPP) “Free and Complete Programming Inclusion of a Computer in the Georgian Natural Language System”. However, we will just briefly discuss methodological applications of Logical Grammar of Georgian Language (LGofGL). The final aim of SPP is mathematical foundation of Georgian Language and Thinking (GLT) and construction of Basic Georgian Intellectual Computer System (BGICS), which, in turn, is just a computer software with the Mathematical Theory of GLT (MTofGLT). Therewith, the main aim of subproject “Foundations of Logical Grammar of Georgian Language and its Methodological and Technological Applications” is to extend the 1-stage MTofGLT to the 2-stage one, and its technological aim is to construct the 1-stage Voice Managed Georgian Intellectual Computer System, shortly VMGeointel_1, which can be estimated as first experimental step to free and complete programming inclusion of a computer in the Georgian Natural Language (GNL) system.

1. Introduction

The fact that till today there does not exist MTofGLT makes evident high scientific novelty of researches defined by SPP. The fact that it is impossible to construct BGICS without working out MTofGLT confirms clearly the very high actuality of mentioned researches.

More than fifty years open research process goes on in order to create Intellectual Computer Systems (ICS). The aim of those processes is to construct computer system with which the users, in the case of any kind intellectual or imperative necessity, will be able to make free and complete communication based only on their native language knowledge.

Today, it is clear, that the future streaming of general world-wide cultural processes can not be considered without active participation of such computers. This makes clear, that if BGICS dose not exist, then Georgians will lose ability to take part in the future cultural processes by means of GL. - High estimation of the SPP was caused by the above mentioned, and, also, this was caused by that circumstance, that, till nowadays, there are no Georgian specialists in contemporary mathematical linguistics.

Main cause that GL is not studied from the point of contemporary mathematical linguistics, is late formation of mathematical logic in Georgia. Because of this Georgian logicians were not involved in the previous processes of Georgian Linguistics researches. It makes clear why there does not exist MTofGLT yet. - The local researches for recovering MTofGLT began only about 10 years ago, and from this point there are still very serious problems in Georgia. The point is that being far from pursuing researches in contemporary mathematical linguistics it is hard to recognize for the part of Georgian mathematicians that these researches are mathematical indeed. - It is hard for them to understand what a crucial role plays mathematics in Chomsky's and Montague's linguistic researches. Only this

and nothing else can be regarded as an explanation of the fact that in 2006 the University reform rejected the studying process in Logic of Natural Languages (NLs) and Mathematical Linguistics, which were founded in 2004-2006 years at the University taking into account research aims of SPP. Appellate process, which we started immediately, brought us to the result, which was announced on February 7, 2008, and according to which the high actuality of rejected studying process was confirmed one more time. - We hope that despite war situation in our country, in near future, once already founded studying process in Logic of NLs and Mathematical Linguistics will return at Tbilisi State University (TSU)..

The above discussed details are not directly related to the topic of our discussion, but they showed clearly that our views on GLT are completely new. Herewith, it is clear, that it is unfair to estimate our first scientific steps and their results by comparing them to western researches and results, which are more advanced than ours¹.

In spite of mentioned, we think that our researches and their results will be interesting for today's advanced world-scientific society: The first reason of this is natural specifics of GLT, which are different from Indo-European one. The second reason is our distinct methods adjusted to mentioned specifics of GLT. These specifics made us to deny Montague's and Chomsky's methods, which are linked to specifics of English Language and Thinking.

But, from general points, LGofGL is a Montagovian Grammar for GLT and, also, from very general points, we are using Chomsky's methods too. Although, we state again, that our methods are basically different from Montague's and Chomsky's basic methods in their fundamental points. This difference is not result of our persistence or wish, but it is result of mentioned natural specifics of GLT, and it was almost impossible to perform our researches without foreseeing these specifics.

2. Brief Survey of Our Fundamental Sights, Results and Research Aims

The theoretical aim of the project is to work out the foundations of LGofGL. It implies representation of the Core Part of GLT (CPofGLT) as Frege-Pkhakadzian formally extendable intellectual mathematical theory. This means to represent CPofGLT as a Euclid and Hilbert type theory through axiomatization and formalization of it.

The technological aim of the project is to construct the VMGeointel_1. It is clear, that this will be obvious confirmation of productivity of our researches.

The methodological aim of the project is elaboration of new knowledge gained due to foundation LGofGL and its gradually introduction into reforming studying processes currently going in Georgia. In this paper, this part of the project is not highlighted².

¹ We, trying to make foundations of LGofGL, are mostly contemporaries to Montague, and, from scientific points, we are mainly in his epoch, but not in the epoch where today's world-wide scientific society is. - It must be marked, that there is no doubt about the value and significance of our researches from local, i.e. from Georgian cultural point of view.

² But, it must be emphasized: We compare teaching NL of Georgian Language (GL) only on the basis of Aristotelian logic to the teaching of German grammar according to English grammar, which obviously will never be done by any rational and sensible society. The

2.1. A brief overview of our lingual ideology: Before we will start discussing natural specifics of GLT, which in fact play the main role in our researches, we would like to say few words about our views on Language. However, it must be noticed, that the views were formed as a result of our researches and of that general semantic approaches, which were developed by Sh. Pkhakadze on the basis of his Notation Theory (NT).

View on a language of Montague, which is based on Frege's artificial Mathematical Language (ML), differs from the Chomsky's view, who tried to study NLs in the confines of NLs and to do this without using any non-natural, i.e. artificial language.

According to our view, like Chomsky's one, it is almost unfair using elements which are out of that natural language and thinking, which we have planned to study¹. In spite of this, we do not exclude ML from the lingual researches. But, differently from Montague, we do not consider ML as a separately standing artificial language from the NLs. Moreover, we think that any natural language and thinking, in its basic, or core part, is founded on Primary ML (PML) and Primary Mathematical Concepts (PMC), which naturally exist in any human.² Moreover, according to our lingual ideology primary semantic data, universally existing in a human, are the Primary Mathematical Theory (PMT), constructed with PML and PMC. - It is clear, that this PMT subconsciously exists in humans. That is why we call the PML of this PMT as Primary NL of Subconscious Level (PNLofSL). We must mention, that one of the basic aim of our researches is recovering of the GTL and, also, recovering of PMT, which are standing at fundamental level of GTL.- **Now, it should be clear, why we call Frege's artificial ML as a NL of subconscious level, and NLs as a NL of conscious level.**

According to our lingual ideology we consider the PMT as universal one, and the PML as universal mediator language system between all human conscious

point is that our researches have already established that Georgian atomic judgment (statement) built up with an indicative verb has different mathematical nature from Aristotelian one.

¹ This is as clear as unfairness of researching one's physical world using elements, which are out of this physical world.

² According to our lingual ideology, the natural laws of GL are in Georgian Written Language (GWL) only partially, these laws are in Georgian Spoken Language (GSL) more completely, and these laws are only in Georgian Thinking Language (GTL) completely and exhaustively. Because of this, we, in our researches, are pointing mainly on the GTL. According to our researches, GWL is completely embedded in GSL, but not vice versa. It was found out that during speaking a Georgian speaker, in order to avoid syntaxes and semantic ambiguity, uses spoken parentheses, and the location of this spoken parentheses is depended on what the speaker wants to say. But, these very important parentheses are not used in GWL. For example, in GWL **Georgian language and logic** is semantically ambiguous because there is no unique restoration of omitted parentheses. Namely, there is two ways to restore parentheses: **(Georgian ((language) and (logic)))** and **((Georgian (language)) and (logic))**. But in GSL a speaker manages to pronounce the same string using spoken parentheses and a listener guesses which version of the string was pronounced. Herewith, not all abilities of GSL are available in GWL. This means that GSL more perfectly represents GTL, than GWL does. Moreover, according to our lingual ideology GTL is ML, which consist of all PMC.

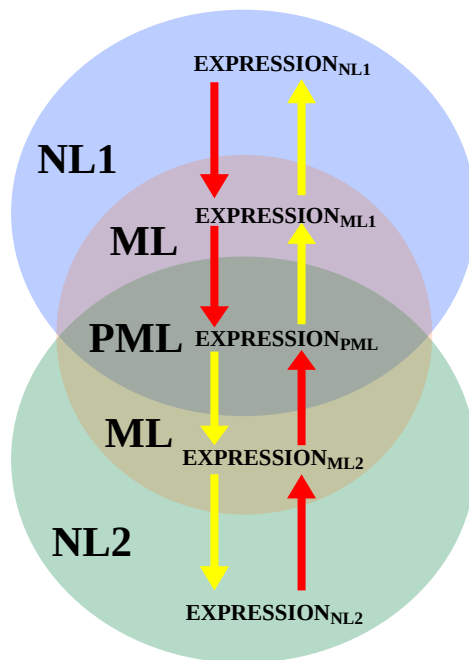
NLs. - This view is founded on the simple belief that, the children, without this PML, will not be able to study a foreign, i.e. non-native language and, also, on the simple belief that without abovementioned mediatorial role of the PML, it would be impossible to make intelligent translation of contents from one language into another one. – For us, to make a complete intelligent translation from one language into another it is necessary, at first, to reduce the language data to its equivalent ML data, and then to produce this universally understandable ML data into the destined language (see figure below).

Now, we are ready to state following three important conclusions:

1. It is known, that Chomsky was interested not only in complete automatic foundation of NLs, he researched universal genetic linguistic program too. Also, it is well known about Montague's researches for a universal grammar and Wierzbicka's attempts to find universal linguistic concepts. Processes to find so-called linguistic universals always accompany lingual researches: **We think that while we are researching NLs it is more important to research various lingual specifics of various NLs, than to research linguistic universals. Herewith, we say that only lingual elements of PMT may be considered as linguistic universals, and the elements by their different extensions give different NLs.**

2. As it is known, a problem of artificial intelligence and a problem of automatic translation are the most important ones from the cultural point of view. Also, it is known that active researches are performed to find mediator language system between other languages. In spite of this, even today, automatic translator

systems are basically constructed for previously taken languages, and while constructing these systems they mostly use statistical methods of translation, than exact intelligent translations through universally agreed mediator language: **We think, that the only way to solve completely the problem of automatic translation is to use the Universally Agreed ML (UAML) as a mediator language system between the NLs. Two-way translation connection between two NLs will be available with the help of two-way translation connections between UAML and these certainly taken NLs. In this case, any NL society will be independently responsible and obliged to provide two-way translation connection of its native**



language with UAML. - Because of universality of mentioned aims, it is clear, that any specifics of any NL must be in the UAML only in their universally, i.e. mathematically understandable form.

3. According to our lingual ideology, semantic problem in NL systems is reduced to problem of understanding. At the same time the problem of understanding is reduced to ability to answer the question – what does it mean? - If

we can define any language expression of any language system on the basis of primary, i.e. basic lingual expressions and lingual expressions, already defined on the basis of primary lingual expressions, then we say that the language system is fully understandable. According to our views the problem of semantics is completely solved in understandable lingual system. In this way, any conscious natural language and thinking is extension of PML and PMT according to formal methods developed by Sh. Pkhakadze in his NT. These formal methods provide the understanding of extended theory when pre-extended theory is understanding¹. **In this way, GLT is the result of final extension of PMT, and CPofGLT is that minimal extension of PMT, full-understanding of which is completely enough for full-understanding of GLT.**

2.2. A brief overview of natural specifics of GLT and results of researches, which are leading to development of MTofGLT: Now, shortly on those natural specifics of GLT, which have caused our above shortly described lingual ideology.

Firstly, why is not Church's λ -operator such necessary for mathematical description of Georgian words as it is for English words: The reason is that English language is one of the most non-morphologic languages among Indo-Europeans. Bloomfield's principle of immediately constituent, which is conditioned because of non-morphologic nature of English and, also, because of English CN type words, which have unfinished nature in the sense of syntaxes and semantic kind lingual relation, makes impossible to make direct mathematical, i.e. functor/argumental, i.e. categorical description of English language. We think, that because of mentioned impossibility, the only way to determine in a well-formed expression a functor/argument nature of English word is to make this through the λ -abstraction of this well-formed expression².

GL is morphologically sufficiently rich and in Georgian there are no words like English words of type CN. This implies that Bloomfield's principle is not acceptable for Georgian and, in same time, this implies existence of natural possibility to make direct mathematical, i.e. categorical i.e. functor/argument description of Georgian words without using λ -abstraction.

This very important difference between Georgian and English languages was confirmed at the first stage of our researches. This lets us make very important insight about Frege's ML and GNL: The Frege's ML and GNL are languages of

¹ Namely, as any new extension of $\mathfrak{T}_n$ theory, i.e. n-times extension of $\mathfrak{T}_0$ theory, with the help of new words or symbols, gives theory, denoted as $\mathfrak{T}_{n+1}$ theory. In spite of that $\mathfrak{T}_{n+1}$ theory is lingual richer than $\mathfrak{T}_n$ theory, but it is completely understanding in case of understanding of $\mathfrak{T}_n$ theory. This means that if we solve the problem of understanding in PML and PMT, then the problem of understanding will be solved in any $\mathfrak{T}_n$ theory automatically. This means that mathematical foundation of $\mathfrak{T}_0$ theory results automatically mathematical foundation of any $\mathfrak{T}_{n+1}$ theory. Herewith, it is very important that the lingual wealth of $\mathfrak{T}_{n+1}$ theory gives us new abilities of constructing simplified intellectual procedures.

² Because, that English words take its syntactic and semantic value according of its location in the well-formed expression, we think, but because of not existence of English lingual intuition in us, we are not categorical, that English words out of well-formed expressions, i.e. on morphologic level have no functor/argument nature!

one and same general type. This insight was based on the fact of general sameness of Georgian words and Frege's mathematical symbols.

Further researches, which were based on prof. Sh. Pkhakadze's NT and his sufficiently general $\mathfrak{S}$ mathematical language ($\mathfrak{S}_{\text{SGML}}$), make deeper our already existing views. In the development of these views, the key role has played Formally Developable $\mathfrak{S}$ Mathematical Language ($\mathfrak{S}_{\text{FDML}}$), which is obtained from $\mathfrak{S}_{\text{SGML}}$ by its extension with prof. Sh. Pkhakadze's Contracting Rules (CR) and the understanding of Georgian noun phrases as a restricted mathematical variables and/or constants, this, as it seems, is very specific feature of the GLT.

On the base of these researches was sufficiently proved the possibility to understand GWL's words, morphemes, punctuation marks and word spaces as symbols of $\mathfrak{S}_{\text{FDML}}$, i.e. as Frege-Pkhakadze's symbols. This lets us declare following statements as **GL's Theses**:

GL's First Thesis: Georgian Conscious NL is a $\mathfrak{S}_{\text{FDML}}$ type Language.

GL's Second Thesis: Georgian Conscious NL is a result of extension of PML.

2.3. A brief comparison of Frege's ML, formally developable Frege-Pkhakadze's ML and GNL: Symbol of Frege's ML, shortly Frege's symbol is characterized by its placeness, which is indicated by a natural number, but symbol of Frege-Pkhakadze's ML, shortly Frege-Pkhakadze's symbol is characterized by its weight, which is indicated by a pair of natural numbers.

The fact that σ is a Frege's n -place symbol is denoted by σ^n and it is called as n -place operator. The fact that σ is a Frege-Pkhakadze's symbol of (m, n) weight is denoted by $\sigma^{(m, n)}$ and it is called as operator-sign¹ of (m, n) weight. Herewith:

1. If $m = 0$ and $n = 0$, then $\sigma^{(0, 0)}$ is called 0-ary 0-place operator-sign. Symbols of this type are as in Frege's, also in Frege-Pkhakadze's MLs. Some time, these symbols are called as non-operator symbols. Any non-operator symbol is an e type variable, or constant (i.e. objective variable or objective constant) or t type variable or constant (i.e. propositional variable or propositional constant)²;

2. If $m = 0$ and $n \neq 0$, then $\sigma^{(0, n)}$ is called as 0-ary n -place operator-sign. Symbols of this type are as in Frege's, also in Frege-Pkhakadze's MLs. Sometimes, these symbols are called as (simple) n -place operators. Further, sometimes, we will use notation σ^n instead of $\sigma^{(0, n)}$.

Type indicator of σ^n operator is $((\alpha)_n, e)$, or $((\alpha)_n, t)$ ordered pair, where $(\alpha)_n = (\alpha^1, \dots, \alpha^n)$ (for any $1 \leq k \leq n$, $\alpha^k \in \{e, t\}$). The first (second), element of the type indicator of σ^n operator is called as places type indicator (result type indicator), of the σ^n operator. A σ^n operator is called substantive (relative), if its result type indicator is e (t). k^{th} element of place type indicator of σ^n operator is called as k^{th} place type indicator of the σ^n operator. σ^n operator is called as special (logical), if for any $1 \leq k \leq n$ its k^{th} place type indicator is e (t). Frege's operator is a general name

¹ One of the main differences between Frege's and Frege-Pkhakadze's languages is that, Frege's general symbol is an operator, but Frege-Pkhakadze's general symbol is an operator-sign. We will see that this is very important difference.

² Here t and e are Montague's basic types.

for special and logical operators. A σ^n operator is called as logical-special, if it is not a Frege's operator.

Sometimes, the places type indicator of σ^n operator is given by $e^{\{e\}}/t^{\{t\}}$ expression (here, $\{e\} \cap \{t\} = \emptyset$ and $\{e\} \cup \{t\} = \{1, 2, \dots, n\}$). It assume that, if the k^{th} place type indicator of the σ^n operator is e , respectively t , than k belongs to the set $\{e\}$, respectively $\{t\}$. Now, it is easy to understand that places type indicator of σ^n special (logical) operator is $e^{\{e\}}/t^{\emptyset}$ ($e^{\emptyset}/t^{\{t\}}$), where $\{e\} = \{t\} = \{1, 2, \dots, n\}$. Let us make agreement of using e^n and t^n expressions instead of $e^{\{e\}}/t^{\emptyset}$ and $e^{\emptyset}/t^{\{t\}}$ expressions.

Now we are ready to make general classification of simple operators of Frege-Pkhakadze's ML according to which there are next six different type operators:

1. $e^n \rightarrow e$ type operator, i.e. n -place special substantive operator;
Exm.: (წითელი(-)) = (red (-)), ((-)მიმატებული(-)) = ((-) plus (-)).
2. $e^n \rightarrow t$ type operators, i.e. n -place special relative operators.
Exm.: [(-)წითელი] = [(-) is red], [(-)წერს(-)] = [(-) is writing(-)];
3. $t^n \rightarrow t$ type operator, i.e. n -place logical relative operator.
Exm.: [[-] და [-]] = [[-] and [-]], [თუ[-], მაშინ [-]] = [if[-], then [-]];
4. $t^n \rightarrow e$ type operator, i.e. n -place logical substantive operator.
Exm.: (ვინც[-]) = (who[-]), (რაც[-]) = (what [-]);
5. $e^{\{e\}}/t^{\{t\}} \rightarrow e$ type operator, i.e. logical-special substantive operator.
Exm.: ((-)უბაროდებს[-]), ((-)ფიქრობდებს[-]) = direct translation is impossible.
6. $e^{\{e\}}/t^{\{t\}} \rightarrow t$ type operator, i.e. logical-special relative operator.
Exm.: [(-)უბარია[-]] = [(-)is happy about[-]], [(-)ფიქრობს[-]] = [(-)thinks[-]];

From above classified operators only the first four operators occur in Frege's ML, but, as we have already seen, the complete mathematical analysis of GLT essentially requires all above described ones.

3. If $m \neq 0$, then $n \neq 0$ and, in this case, a symbol $\sigma^{(m, n)}$ is called m -ary n -place operator-sign, shortly m -ary operator-sign. Moreover, if $\sigma^{(m, n)}$ is m -ary n -place operator-sign and $v_1, \dots, v_n$ are so-called operator letters, then $\sigma^{(m, n)} v_1 \dots v_n$ is a compound, or complex n -place operator.

Binding indicator of $\sigma^{(m, n)}$ operator-sign is a non-empty subset $\{k_1, k_2, \dots, k_j\}$ of the set $\{1, 2, \dots, n\}$. $\sigma^{(m, n)}$ is called a complete (partial) operator-sign, if $\{k_1, k_2, \dots, k_j\} = \{1, 2, \dots, n\}$ ($\{k_1, k_2, \dots, k_j\} \subset \{1, 2, \dots, n\}$). If $\sigma^{(m, n)}$ is a complete operator-sign, then n -place compound $\sigma^{(m, n)} v_1 \dots v_n$ operator bounds in all its operands all free occurrences of $v_1, \dots, v_n$ operator letters and nothing more. If $\sigma^{(m, n)}$ is a non-complete, i.e. partial operator-sign with binding indicator $\{k_1, k_2, \dots, k_j\}$ then n -place compound $\sigma^{(m, n)} v_1 \dots v_n$ operator bounds all and only free occurrences of $v_1, \dots, v_n$ operator letters and bounds them only in those operands which are placed in k_1^{th} , k_2^{th} , ..., k_j^{th} operator places.

We have already seen that when six different type simple operators are in Frege-Pkhakadze's ML, from them only four are in Frege's ML. Also, we have already seen, that Frege-Pkhakadze's language almost completely describes various operators existing in GL. But, it is clear, that all six above described operators can be produced by categorical approaches, founded on basic types e and t . That is why we do not consider variety of simple operators of Frege-Pkhakadze's language as main difference between this language and Frege's one.

Besides this, as it was already mentioned, Frege's and Frege-Pkhakadze's MLs differ essentially from each other. Namely, lingual symbol characterized with weight, i.e. operator-sign is that new lingual idea, because of which these two languages are classified as MLs of different types. - Any way, there are two ways: or $\sigma^{(m, n)}$ m -ary n -place operator-sign is an unfair lingual idea, or the conclusion made above must be taken into account.

It is well known, that from pure mathematical points of view the high validity of Prof. Sh. Pkhakadze's approaches are confirmed fully. Now, about linguistics validity of Prof. Sh. Pkhakadze's above shortly described approaches: Our researches let us say, that in languages, similar to GL, where naturally exist restriction variables and constants, quantifier words, because of their naturally existing lingual and logical nature, must be understood as operator-signs of Frege-Pkhakadze's language. - In other words, this means, that the restricted free and bound constant and variables, which are presented in Georgian simple sentences by simple and complex noun phrases make unreasonable to analyze Georgian quantifiers using operator approaches that are developed in the confines of theory of Generalized Quantifiers.

Herewith, that we use Prof. Sh. Pkhakadze's approaches in mathematical processing of quantifiers in GL, is one of the basic differences between our researches and those ones which are pursuing today.

It must be underlined that according to already pursued researches it is proved that above mentioned understanding of Georgian quantifier completely coincides with the nature semantic of it. This was the one of, but not only main argument which made us take Prof. Sh. Pkhakadze's approaches as a basis of our researches.

Another natural feature of GLT, which made us take at our second stage researches as basic formal tool $\mathfrak{F}_{\text{FDML}}$ is the evident existence in Georgian Prof. Sh. Pkhakadze's contracted symbols. For example, in GL simple verbs are obviously distinguishable from verbs of integrated understanding, which are Prof. Sh. Pkhakadze's contracting symbols, because they are formally defined by simple Georgian verbs according to the CRs of NT. - This is widely characterizing specific of GL.

All these reasons together make clear that $\mathfrak{F}_{\text{FDML}}$ allows us more completely and more naturally solve difficulties of semantic study of Georgian verbs and this, in turn, is one more important argument that made us pursue our researches basing on $\mathfrak{F}_{\text{FDML}}$.

2.4. Some examples to enlighten above mentioned theoretical points:

Below we will consider some examples to enlighten our theoretic approaches and the differences, which are between that ours and classical one.

ვამლო არის წითელი (1) ეს არის ვამლო (2) ეს ვამლო წითელია (3)

apple is red (1) this is apple (2) the apple is red (3)

1. In GTL full stop of declarative sentences is a contracted, i.e. abbreviated symbol determined as $[S]$. — $[S]=t$ (S is a sentential variable, t is truth value "true").

2. In GTL the word *ვამლო(apple)* has dual nature: In (1) the word *ვამლო(apple)* represents non-proper constant, which we denote as $(\text{ვამლო})^c((\text{apple})^c)$. In (2) the word *ვამლო(apple)* is a proper constant and it represents the set of all apple, which we denote as $\{\text{ვამლო}\}(\{\text{apple}\})$. To understand fully the word *ვამლო(apple)*, it

must be mentioned, that in (1) the area of definition of it is the set $\{ვაშლი\}(\{apple\})$.

3. In CPofGLT the word *არის(is)* is a simple contracted, i.e. lingual expressing form of the well known left-and-right 1-place operator $[-_1 \in -_2]$.

4. In GTL Georgian word *წითელი (red)* is understood as set of all red things, which we denote as $\{\text{წითელი}\}(\{red\})$.¹

5. In GTL the word *ეს(this) (ყველა(every))* is understood as operator-sign of weight (1,1). It operates on non-proper constant and transforms in proper constant (bound variable). Because of this, we call it as a transformer.²

6. In GLT the word *წითელია(is_red)* is a contracted word, which abbreviates lingual form *არის_წითელი(is_red)*, which, in turn, abbreviates 1-place lingual-mathematical predicate $[(\neg_1) \in \{\text{წითელი}\}] = t$ ($[(\neg_1) \in \{red\}] = t$).

Below, in the first column, there is given results of reduction of sentences (1), (2), (3) according to reduction methods elaborated on the bases of the new views and results obtain by direct formal-logical description of GL. In the second column, there is given deeper mathematical forms of the same sentences.

(1) $[(\text{ვაშლი})^c \in \{\text{წითელი}\}] = t$	$[a \in \{\text{ვაშლი}\}; A = \{\text{ვაშლი}\}: a \in A] = t$
(1) $[(\text{apple})^c \in \{red\}] = t$	$[a \in \{apple\}; A = \{red\}: a \in A] = t$
(2) $[(\text{ეს}(\neg)^c)^p \in \{\text{ვაშლი}\}] = t$	$[q \in \{\neg\}; A = \{\text{ვაშლი}\}: q \in A] = t$
(2) $[(\text{this}(\neg)^c)^p \in \{apple\}] = t$	$[q \in \{\neg\}; A = \{apple\}: q \in A] = t$
(3) $[(\text{ვაშლი})^c][\text{წითელია}] = t$	$[a \in \{\text{ვაშლი}\}: \text{წითელია}(a)] = t$
(3) $[(a \text{ apple})^c][is_red] = t$	$[a \in \{apple\}: is_red(a)] = t$

(4) every man walks — (4.1) $\forall x: (man'(x) \Rightarrow walk(x))$

(4.2) $\forall x \in \{man\}: walk(x)$

(4.3) $x \in \{man\}: [walk(x) = t]$

(5) some man walks --- (5.1) $(\exists x) (man'(x) \& walk(x))$

(5.2) $\forall x \in A: walk(x) \& \forall x \in \{man\} \setminus A: \neg walk(x) \& A \subset \{man\} \& A \neq \emptyset$

(5.3) $x \in A: [walk(x) = t] \& x \in \{man\} \setminus A: [walk(x) = f] \& A \subset \{man\} \& A \neq \emptyset$

(6) every student is reading a book --- (6.1) $(\forall y)[student(y) \Rightarrow (\exists x)(book(x) \& read(y, x))]$

(6.2) $\forall x \in \{student\} \exists y \in \{book\}: read(x, y)$ (6.3) $x \in \{student\} a(x) \in \{book\}: read(x, a(x))$

(6.4) $\forall x \in \{student\} \exists y \in \{book\}: x \in \{reading(y)\}$

(6.5) $x \in \{student\} a(x) \in \{book\}: x \in \{reading(a(x))\}$

Above (4.1),(5.1),(6.1) are classical translations of (4),(5),(6) sentences. (4.1), (5.1),(6.1) are reduction forms of (4),(5),(6) sentences according to our approach based on restricted quantifiers. (4.2),(5.2),(6.2) are reduction forms of

¹ The set $\{\text{წითელი}\}$, differently from the set $\{\text{ვაშლი}\}$, is linearly ordered by redness quality. Also, word *წითელი(red)* in noun phrase *წითელი ვაშლი(a red apple)* differs from the same word in the sentence (1): In the noun phrase **red** is contracted, i.e. abbreviated form of $\{\text{წითელი}\} \cap \neg_1 (red \neg_1 \text{----} \{red\} \cap \neg_1)$, which is left 1-place lingual-mathematical operator. This shows that by word space in the *წითელი ვაშლი(a red apple)* is assumed well known operator of intersection, when by word space in *არის წითელი(is red)* in the sentence (1) is assumed formal operator of placing by activity of which *წითელი(red)* is placed in right place of *არის(is)*.

² by word space in *ვაშლი არის (apple is)* and *ეს არის (this is)* are assumed formal operator of placing, by activity of which *ვაშლი(apple)* and *ეს (this)* are placed in right place of *არის(is)*. Also, in spite that, in sentence (2) the word *ეს (this)* is without its argument in GTL it is understood together with its assumed argument.

(4),(5),(6) sentences according to our approach based on restricted existential and universal constants (variables).

3. A Survey of Research Aims and Basic for Creating VMGeointel_1

Technological aim of subproject “Foundations of Logical Grammar of Georgian Language and its Methodological and Technological Applications” assumes systematical representation of the technological possibilities of LGofGL and already current theoretical researches for construction speech recognition and synthesizer systems for Georgian. It means that we have aimed to construct the VMGeointel_1 system on the bases of already existing 1-stage MTofGLT and 1-stage Georgian speech recognition and synthesizer systems. To this direction there is planned:

1. Implementation the knew knowledge obtain within the bound of 1-stage MTofGLT in already current researches for construction speech recognition and synthesizer systems for Georgian: Our approaches are based on extended inter-zero analysis method and matrix methods of computation¹. In 2008, there is realized speech recognition system which gives 97% recognition for sentences in case of the discrete speech with dictionary including 300-350 words. There is planned to construct such speech recognition, which will base not on the principle in advance teaching of words, but self-teaching one. If at the first stage of our researches for the construction ‘Georgian computer ear’ was used only Georgian sound data, by now is planned to construct speech recognition on the base of our 1-stage researches for the elaborating MTofGLT. This means that we aim to construct ‘Georgian non-primitive, i.e. thinking ear’ instead of ‘Georgian primitive phonemic ear’.

2. Construction of 1-Stage Morpho-Syntaxes Synthesizer, Analyzer and Checker System for GWL: From this point we based on our experimental 1-stage morpho-syntaxes synthesizer, analyzer and checker systems, which are the first such type programs for GL². At the same time, there is planned to construct experimental 1-stage morpho-syntaxes speech-checker for GSL.

3. Construction 2-Stage Logical Synthesizer, Analyzer and Checker System for GWL: From this point of view we based on our experimental 1-stage Logical Synthesizer, Analyzer and Checker Systems, which are the first such type program systems for GWL³. At the same time, there is planned to construct experimental 1-stage Logical Synthesizer, Analyzer and Checker System for GSL.

4. Two-side Automated Translator Systems from GWL into the ML and from GWL into German and English ones through the ML: From this point we are based on our experimental 1-stage automated translator system from GWL into the ML and from GWL into German by using ML as a mediator

¹ It must be underlined that, unfortunately, for such type program realization necessary researches are carried out only inside of our group, and, correspondingly, only our group is working out speech recognition problem of Georgian Language.

² It must be underlined that till nowadays there are not in common use any morpho-syntaxes synthesizer, analyzer and checker system for GWL.

³ It must be underlined that, unfortunately, for such type program realization necessary researches are carried out only inside of our group, and, correspondingly, only our group is working for construction logical synthesizer, analyzer and checker, i.e. for construction automatic prover and reasoning system for GWL.

Language¹. At the same time, there is planned to construct first two-side voice to voice 1-stage automated translator system from Georgian into English and German.

5. 1-Stage Computer System with the Reading Ability in GWL, i.e.

GWreader_1: Computer software by GWreader_1 System will be equipped with non-restricted non-semantic (restricted semantic) reading ability: This means that the System will read any GWL's text without any correction (in morphologically, syntactically, logically, and semantically corrected form) of it. Herewith, during the construction of GWreader_1 system, we will use methods of natural division of Georgian words into syllables and of natural reading of Georgian phrases, which were worked out in limits of current theoretical researches in our group.

6. 1-Stage Computer System with the Listening Ability in GSL, i.e.

GSlistener_1: Computer software by GSlistener_1 System will be equipped with the limited non-semantic (semantic) listening ability. This means that the system will listen a text of GSL with the basic dictionary about 100 – 200 words, and will give a listened text in its direct, i.e. non-corrected (non-direct, i.e. corrected) written form. It is available to increase the quality of recognition of the system from 90% to 100% in the way of selection of the words and their number in basic dictionary. This means that this system sometimes can be used as a faultless automatic typewriter. The system will not be constructed on the principle of learning of written and spoken forms of the dictionary words, but it will be constructed on the principle of internal listening of written forms of the dictionary words. This means that the system is not limited by users' voice. Although, the system will be constructed in such way that it will necessarily demand slightly paused, i.e. moderated discrete speech from any user.

6. 1-Stage Voice Manager Computer system, i.e. GVManager_1

system: Computer software by GVManager_1 system expands computer-user communication abilities. Namely, GVManager_1 system allows user to give the computer user-defined standard and non-standard commands via Georgian voice signal.

GVManager_1 system consists of WithDP_GVManager_1 and OutDP_GVManager_1 subsystems. WithDP_GVManager_1 will make a dialogue with user or in a written or in voice form. This will help user to understand whether the system has correctly understood the command, after this user orders the system to accomplish the correctly understood command. It is obvious that for blind users voice dialogue and for deaf users written dialogue modes are the modes without alternatives. Users having none of above mentioned disabilities will use these two modes as they wish according to the situation and their current aims.

7. Through Combination of Above Mentioned Program Systems to Construct 1-stage Voice Managed Georgian Intellectual Computer System,

shortly VMGeointel_1: Computer, which will be software by VMGeointel_1 system will be equipped with:

1. Abilities to give user-defined standard and nonstandard commands via Georgian voice signal;

2. Abilities to solve Georgian logical tasks and critically analyze Georgian logical judgments given in GWL and GSL.

¹ It must be underlined that for such type program realization necessary researches are carried out only inside of our group.

3. Abilities to translate from GWL and GSL into English and German written Languages by using ML as a mediator Language;

4. General thinking abilities in GWL and GSL. It means, that these systems equip computer with abilities to make morphologic, syntactic, logical and common-semantic spellchecking of texts of GWL and GSL. In the same time, it means, that the systems equip computer with abilities to reduce any sentence of CPofGWL and CPofGSL to CPofGTL, and vice versa (i.e. to produce (restore) any well-formed expression of CPofGTL in CPofGWL and CPofGSL).

5. Fully non-semantic and partially semantic reading ability in GWL and partially non-semantic and partially semantic listening ability in GSL.

Herewith, as it was mentioned already, VMGeointel_1 system, which is the final technological aim of the one year subproject of SPP, at the same time, is the first experimental step to Free and Complete Programming Inclusion of a Computer in the GNL System. - We know, that above described VMGeointel_1 system and its constituents are not comparable with theirs contemporary analogies, but, we are underlining one more time, that the system has no analogue from the points of local, i.e. Georgian reality.- About causes of this, in the paper, it was already mentioned.

List of Abbreviations

SPP	State Priority Program
LGofGL	Logical Grammar of Georgian Language
GLT	Georgian Language and Thinking
BGICS	Basic Georgian Intellectual Computer System
MTofGLT	Mathematical Theory of Georgian Language and Thinking
GNL	Georgian Natural Language
ICS	Intellectual Computer Systems
NL	Natural Language
TSU	Tbilisi State University
CPofGLT	Core Part of Georgian Language and Thinking
GL	Georgian Language
NT	Notation Theory
ML	Mathematical Language
PML	Primary Mathematical Language
PMC	Primary Mathematical Concepts
PMT	Primary Mathematical Theory
PNLofSL	Primary Natural Language of Subconscious Level
GWL	Georgian Written Language
GSL	Georgian Spoken Language
GTL	Georgian Thinking Language
UAML	Universally Agreed Mathematical Language
CR	Contracted Rules
$\mathfrak{S}_{\text{SXML}}$	Sufficiently General $\mathfrak{S}$ Mathematical Language
$\mathfrak{S}_{\text{FDML}}$	Formally Developable $\mathfrak{S}$ Mathematical Language

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