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THE FIRST VERSION OF THE INTELLECTUAL COMPUTER SYSTEM IN THE GEORGIAN WRITTEN LANGUAGE

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Abstract. The technological aim of L.Abzianidze's and A.Maskharashvili's Masters Theses (MTs) is to construct the First Version of the Intellectual Computer System (ICS) in the Georgian Written Language (GWL). This technological aim[1] is defined by the technological and theoretical aims of the subproject "Foundations of Logical Grammar of Georgian Language and its Methodological and Technological Applications" of the Tbilisi State University (TSU) State Priority Program (SPP) "Free and Complete Programming Inclusion of a Computer in the Georgian Natural Language System". At the same time, this technological aim is defined by the theoretical aim of the above mentioned MTs. Thus, we consider a successful realization of the above mentioned technological aim as that successful experiment, which proves a validity and productivity of the theoretical results of the above mentioned sub-project and MTs. Herewith, the aim of the article is to make the short overview of the theoretical bases and expected technological result of the above mentioned MTs, general title of which is "The Mathematical Analysis of Georgian Declarative Verbs and the First Version of The Intellectual Computer System in Georgian Written Language".

Keywords and phrases: First Version of the Intellectual Computer System in the Georgian Written Language, Georgian Lingual ideology, Universally Agreed Mathematical Language.

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1. Introduction. More than fifty years the open research processes go on in order to create ICS. These processes are aimed to the construction of such computers, which will be able to be used without any special programming knowledge. This assumes that users will have the possibility to interact with them basing only on their native language knowledge. Today, it is clear, that such type intellectual computers will play very wide and very crucial role in the future streaming world-wide cultural processes. This, in turn, makes clear, that if Georgian society is not able to construct such Georgian ICS, then it is very plausible that after 12-15 years Georgians will completely lose ability

[1]Final aim of the TSU SPP is mathematical and mechanical foundations of the Georgian Language and Thinking (GL&T). This assumes an elaboration of Mathematical Theory of Georgian Language and Thinking and construction of the basic Georgian Intellectual Computer System, which, in turn, is nothing more than a computer softwared with the Mathematical Theory of Georgian Language and Thinking.

of taking part in the future world-wide cultural processes by means of GL. The high estimation of the TSU SPP together with mentioned is caused by that circumstance, that till nowadays GL is almost completely unstudied from the points of contemporary Mathematical Linguistics (ML), without which any attempt to construct Georgian ICS of the above underlined type is hopeless. The main cause that GL is not studied from the point of contemporary ML is the late formation of mathematical logic in Georgia. Because of this Georgian logicians were not involved in the previous researches of GL. It makes clear why till today there does not exist even completely systematized partial mathematical grammar for GL, and, also, why there does not exist even partial parser of syntactic type for it.

The local researches for creating Mathematical Theory (MT) of GL&T (MTofGL&T) began only 10 years ago [1-8], and from this point there are still very serious problems in Georgia. The point is that being far from the current 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 discrete mathematics and mathematical logics in Chomsky's and Montague's linguistic researches! This fact and nothing else explains that in 2006 TSU reform rejected the studying process in Logic of Natural Languages and Mathematical Linguistics, which were founded in 2004-2006 years. - We hope, that in near future, these studying processes will return at TSU.

2. Shortly About of the First Version Intellectual Computer System in the Georgian Written Language. Below there is given a general description of the first version of the Intellectual Computer System in the Georgian Written Language (GWL), which is shortly denoted as GWLintel_1:

(1) - **GWLintel_1**
- **GWLabstractor_1** (1.1)
- **GWLsynthesizer_1** (1.2)
  - **GWLwordsynthesizer_1** (1.2.1)
  - **GWLsentencesynthesizer_1** (1.2.2)
  - **GWLtextsynthesizer_1** (1.2.3)
- **GWLchecker_1** (1.3)
  - **GWLwordchecker_1** (1.3.1)
  - **GWLsentencechecker_1** (1.3.2)
  - **GWLtextchecker_1** (1.3.3)
- **GWLanalyzer_1** (1.4)
  - **GWLwordanalyzer_1** (1.4.1)
  - **GWLsentenceanalyzer_1** (1.4.2)
  - **GWLtextanalyzer_1** (1.4.3)
- **GWL-GMLconnect_1** (1.5)
  - **GWLtoGMLreducer_1** (1.5.1)
    - ***GWLabstractor_1*** *(1.5.1.1) = (1.1)*
    - ***GWLchecker_1*** *(1.5.1.2) = (1.3)*
    - ***GWLanalyzer_1*** *(1.5.1.3) = (1.4)*
  - **GMLtoGWLproducer_1** (1.5.2)
    - ***GWLsynthesizer_1*** *(1.5.2.1) = (1.2)*
- **GWLthinker_1** (1.6)
  - **GWLreasoner_1** (1.6.1)
    - ***GWLtoGMLreducer_1*** *(1.6.1.1) = (1.5.1)*
    - **GMLreasoner_1** (1.6.1.2)

- ***GMLtoGWLproducer_1*** *(1.6.1.3) = (1.5.2)*
- **GWLtheoremprover_1** (1.6.2)
  - ***GWLtoGMLreducer_1*** *(1.6.2.1) = (1.5.1)*
  - **GMLtheoremprover_1** (1.6.2.2)
  - ***GMLtoGWLproducer_1*** *(1.6.2.3) = (1.5.2)*
- **GWLtasksolver_1** (1.6.3)
  - ***GWLtoGMLreducer_1*** *(1.6.3.1) = (1.5.1)*
  - **GMLtasksolver_1** (1.6.3.2)
  - ***GMLtoGWLproducer_1*** *(1.6.3.3) = (1.5.2)*
- **GWLreasoningchecker_1** (1.6.4)
  - ***GWLtoGMLreducer_1*** *(1.6.4.1) = (1.5.1)*
  - **GMLreasoningchecker_1** (1.6.4.2)
  - ***GMLtoGWLproducer_1*** *(1.6.4.3) = (1.5.2)*

- **GWLinteltranslator_1** (1.7)
  - **GWL-EngWLtranslator_1** (1.7.1)
    - ***GWLtoGMLreducer_1*** *(1.7.1.1) = (1.5.1)*
    - **GMLtoEngWLproducer_1** (1.7.1.2)
    - **EngWLtoGMLreducer_1** (1.7.1.3)
    - ***GMLtoGWLproducer_1*** *(1.7.1.4) = (1.5.2)*
  - **GWL-GerWLtranslator_1** (1.7.2)
    - ***GWLtoGMLreducer_1*** *(1.7.2.1) = (1.5.1)*
    - **GMLtoGerWLproducer_1** (1.7.2.2)
    - **GerWLtoGMLreducer_1** (1.7.2.3)
    - ***GMLtoGWLproducer_1*** *(1.7.2.4) = (1.5.2)*
  - **EngWL-GerWLtranslator_1** (1.7.3)
    - ***EngWLtoGMLreducer_1*** *(1.7.3.1) = (1.7.1.3)*
    - ***GerWLtoGMLreducer_1*** *(1.7.3.2) = (1.7.2.3)*
    - ***GMLtoEngWLproducer_1*** *(1.7.3.3) = (1.7.1.2)*
    - ***GMLtoGerWLproducer_1*** *(1.7.3.4) = (1.7.2.2)*[2]

Thus, GWLintel_1 consists of GWLabstractor_1, GWLsynthesizer_1, GWLchecker_1, GWLanalyzer_1, GWL-GMLconnector_1, GWLthinker_1, GWLinteltranslator_1 subsystems and its already realized demo version. GWLintel_1 is the first ICS in the Core Part (CP) of GWL (CPofGWL). Below there are considered its subsystems separately:

1.1. GWLabstractor_1 system basing on the main lexicon of the Geointel_1 system, takes an expression of CPofGWL as input datum and gives its abstract form or forms as an output result. A resulted abstract form is called as an abstract expression of CPofGWL.

1.2. GWLsynthesizer_1 system takes as input datum an abstract expression and written lingual data of CPofGWL and gives as an output result a written lingual form, which is result of concretization of the input abstract expression by the input written lingual data.

1.3. GWLchecker_1 system takes as input datum an expression of CPofGWL and checks it in non-dialog (i.e. automatic), or in dialog (i.e. non-automatic) mode and gives as an output result the fully corrected form of the input expression. This checked expression is called as well-formed expression of CPofGWL.

1.4. GWLanalyzer_1 system takes as input datum a well-formed expression of CPofGWL, mathematically analyses it on the base of main lexicon of the Geointel_1 system and gives as an output result its complete bracketing form. This complete bracketing form is called as well-formed bracketing expression of CPofGML.

1.5. GWL-GMLconnector_1 system realizes two-way connection between CP of GWL and CP of GML. Namely, GWLtoGMLreducer_1 system, which is a subsystem of GWL-GMLconnector system, takes as input datum a well-formed bracketing expression of CPofGML and gives as an output result its semantically equivalent mathematical expression. This mathematical expression is called as well-wormed mathematical expression of CPofGML. GMLtoGWLproducer_1 works in vice versa, i.e. it takes as input datum a well-formed mathematical expression of CPofGML and gives as an output result its semantically equivalent expression of CPofGWL.

1.6. GWLthinker_1 system consists of GWLreasoner_1, GWLtheoremprover_1, GWLtasksolver_1, GWLreasoningchecker_1 subsystems. Below we will consider them very briefly:

1.6.1. GWLreasoner_1 system takes as input datum one or two declarative sentences of CPofGWL and makes all possible general conclusions, which are implied with given sentences as premises in CPofGWL.

1.6.2. GWLtheoremprover_1 system takes as input datum a text of CPofGWL and as an output result gives its proof, or the system gives as an output result a confirmation that it is unable to prove the given input, or the system gives as an output results a confirmation that the given input is not a theorem of CPofGWL.

1.6.3. GWLtasksolver_1 system takes as input datum a textually formed task only by means of CPofGWL and it gives as an output result its solution, or a confirmation that the given task is unable to be solved uniquely, or a declaration that the system is unable to solve this task.

1.6.4. GWLreasoningchecker_1 system takes as input datum a textually formed reasoning, which is formed only by means of CPofGWL and it gives as an output result a confirmation that the given input is a right (i.e. well-formed) reasoning, or declaration that the input is not a right (i.e. well-formed) reasoning and in this case the system gives report about the mistake, which was found in the false input "reasoning" and if this is possible, the system checks the input "reasoning" and as an output result gives this already checked right, i.e. well-formed reasoning.

1.7. GWLinteltranslator_1 system consists of GWL-EngWLtranslator_1, GWL-GerWLtranslator_1, EngWL-GerWLtranslator_1 systems. Below we will consider them very briefly:

1.7.1. GWL-EngWLtranslator_1 system takes as input datum a text of CP of GWL (CPofEngWL) and gives as an output result the translation of input text in CP of Eng WL (CPofGWL) using GML as mediator language.

1.7.2. GWL-GerWLtranslator_1 system takes as input datum a text of CPof GWL (CPofGerWL) and gives as an output result the translation of input text in CPofGer
WL (CPofGWL) using GML as a mediator language.

1.7.3. EngWL-GerWLtranslator_1 takes as input datum a text of CPofEngWL (CPofGerWL) and gives as an output result its translation in CPofGerWL (CPofEngWL) using GML as a mediator language.

3. About Our Ideological Bases. Below, we will discuss ideological bases of our above described technological aim [9-10]: according to Georgian Lingual Ideology

(GLI) any natural language and thinking is a result of that step by step extensions of primary mathematical language and theory, where, in any step of mentioned extensions, the extensions are realized according to extension rules of this natural language and thinking system[3]. - So, now we are ready to declare our views on genesis of Georgian language and thinking and on the problems of construction of artificial intelligence and automatic translator systems for the Georgian language:

1. According to the GLI, the GWL, which is a sub-language of the Georgian Spoken Language (GSL), based on Georgian mathematical language (GML): this means that according to the GLI the GSL and the GWL are result of the extension of GML, when the GML is a result of extension of Primary Mathematical Language (PML). At the same time, the extensions are performed by using Georgian rules of extension, which rules, in generally sense, coincide with of Prof. Sh. Pkhakadze's contracted rules.

2. According to the GLI, in order to make some type intellectual processing of some type text of GWL, for example, to solve some textually given task, first of all, we reduce this text to its equivalent text (task) of GML, and only after this reducing we begin to process (to solve) it in GML and through parallel producing the results of mentioned processing (solving) processes in GML we perform the processing (solution) of the given text (task) in GWL.

3. Even today for construction automatic translator systems for certain languages is mainly used statistical methods of translation. On the basis of GLI we think that the only way to solve completely the problem of automatic translation is to form and to use called by us as a Universally Agreed Mathematical Language (UAML) as a mediator language system between the different Natural Languages (NLs). In this case two-way translation between two NLs will be available with the help of two-way translation between UAML and these certainly taken NLs and, at the same time, in this case any NL society will be independently responsible to provide this 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. In figure 1 there is pictured how we have constructed GWLinteltranslator_1 system, by which two-way translation relations are realized between Georgian, English and German languages according to the above declared approach. But, here, GML is used as a mediator language instead of UAML.

[3]The truth of the above stated view for GLT is already sufficiently proved, and this is one of the main result of our researches.

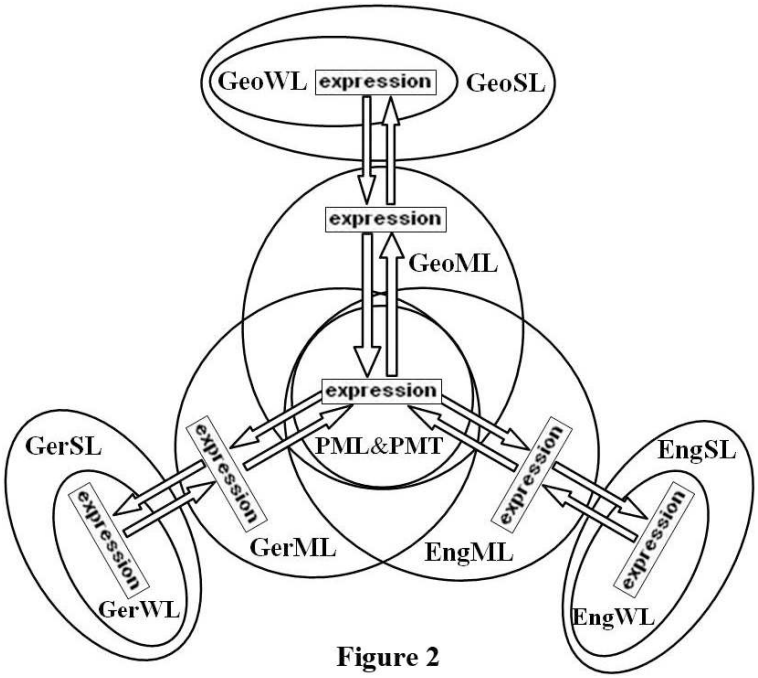

Figure 2

R E F E R E N C E S

1. Pkhakadze K. About Syntactic Relation Between Words, *GEU, Journal "Iveria", Paris*, **VII-VIII** (2002-2003), 117-126 (in Georgian).

2. Pkhakadze K. (with co-authors), About the Main Ideas of the Direct Formal-Logical Description of the Georgian Natural Language System Through the Examples, *Proceedings of the V Tbilisi Symposium on Language, Logic and Computation, University of Amsterdam*, 2003, 129-137.

3. Pkhakadze K. A fragment of the Georgian Natural Language System as a Set-Theoretic System, *GEU, Journal "Iveria", Paris*, **X-XI** (2003-2004), 104-116 (in Georgian).

4. Pkhakadze K.(with Co-Author), About Main Ideas of Direct Formal-Logical Description of the Georgian Language, *Proceedings of I. Vekua IAM, Tbilisi*, **53** (2004), 33-40.

5. Pkakadze K. (with co-authors), The Logical-linguistics Analysis of the Georgian Lingvo-logical System on the Base of the $\Im$ Notation Theory, *The IV Congress of The Georgian Mathematics*, 2005.

6. Pkhakadze K. (with Co-Author), On the Linguistic Relations and Logical Declension in Georgian, *S-E Journal "Georgian Language and Logic"*, **1**, (2005), 19-77 (in Georgian).

7. Pkhakadze K. (with co-author), General Quantifier-Predicative Analysis of the Georgian Language and First Experimental Version of the Logical Reasoner for Georgian, *S-E Journal "Georgian Language and Logic"*, **2** (2005), 82-87 (in Georgian).

8. Pkhakadze K. (with co-author), Georgian-German Translator and Syntaxes Type Synthesizer and Analyzer for Georgian, *S-E Journal "Georgian Language and Logic"*, **2** (2005), 88-91 (in Georgian).

9. Pkhakadze K. Abzianidze L., Maskharashvili A. (with co-authors), Fundamental Questions of the mathematical theory of the natural logic of the Georgian natural language system, *V Conference on NLP of Arn. Chiqobava Institute of Linguistics, Tbilisi*, 2007, 42-44.

10. Pkhakadze K. Abzianidze L., Maskharashvili A. (with co-author), About 1-Stage Voice Managed Georgian Intellectual Computer System, *Seminar of I. Vekua Institute of Applied Mathematics,*

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