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on
Modern Problems in Applied
Mathematics**

Dedicated to the

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&

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I. Vekua Institute of Applied Mathematics

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INTERNATIONAL CONFERENCE
ON
"MODERN PROBLEMS IN APPLIED MATHEMATICS"



*Dedicated to the 90th Anniversary of the Iv. Javakhishvili Tbilisi State University
and
40th Anniversary of the I.Vekua Institute of Applied Mathematics*

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გამოყენებითი მათემატიკის თანამედროვე პრობლემები

ექვნება

ივ. ჯავახიშვილის სახელობის თბილისის
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"გამოყენებითი მათემატიკის თანამედროვე პრობლემები"

ექვნება

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Contents

SECTION: Foundations of Mathematics and Mathematical Logic	11
A. B. Kharazishvili. SOME APPLICATIONS OF ALMOST DISJOINT FAMILIES OF SETS	11
A. Kipiani. ONE ALGEBRAIC CHARACTERIZATION OF UNCOUNTABLE CARDINALS LESS THAN THE CARDINALITY OF THE CONTINUUM	11
A. Kirtadze. SOME APPLICATIONS OF SET-THEORETICAL METHODS IN THE THEORY OF QUASI-INVARIANT MEASURES	12
Antonio Di Nola, Revaz Grigolia, Luca Spada. ON FREE CYCLIC MV -ALGEBRAS	13
R. Sh. Omanadze. ON STRONGLY EFFECTIVELY LEVELABLE SETS	13
G. Pantsulaia. A RELATION BETWEEN SOME TRANSLATION-INVARIANT BOREL MEASURES ON \mathbb{R}^∞	14
SECTION: Applied Logics and Programming	15
J. Antidze, N. Gulua. MACHINE TRANSLATION FROM GEORGIAN LANGUAGE	15
N.Archvadze, M.Pkhovelishvili, L.Shetsiruli. THE METHODS OF THE EFFECTIVE DATA SEARCH FOR THE LISTED STRUCTURES	16
G. Chankvetadze. INTERNATIONAL MONEY TRANSFER SYSTEM "ALPHA EXPRESS"	16
B. Dundua. A SYSTEM FOR RULE-BASED PROGRAMMING WITH SEQUENCE AND CONTEXT VARIABLES ...	17
G. K. Fedulov. ONE-DIMENSIONAL BIN PACKING CLASS: FAST BOUNDS OF OBJECTIVE FUNCTIONS	17
K. Pkhakadze, G. Chichua, L. Abzianidze, A. Maskharashvili. ABOUT 1-STAGE VOICE MANAGED GEORGIAN INTELLECTUAL COMPUTER SYSTEM	18
K. Pkhakadze, L. Abzianidze, A. Maskharashvili. GEORGIAN LANGUAGES THESES	19
Kh. Rukhaia, L. Tibua, G. Chankvetadze. MODIFIED $M\tau SR$ THEORY	20

$C_i \geq B, i \in [1, M]$, the B is a bin quota. For a **Bin Packing & Bin Covering Hybrid** we wish to divide A into a minimum (**Model 3**) or maximum (**Model 4**) number (M) of subsets: $B_{\min} \leq C_i \leq B_{\max}, i \in [1, M]$, where the parameters B_{\min} and B_{\max} are the lower and upper thresholds respectively. All models 1-13 we lead to a **Model 0** in process of solving. Given a fixed list of bins $L = \{B_1, B_2, \dots, B_M\}$, the B_i is a capacity of i -th bin. We need to pack the A to the L : $C_i \leq B_i, i \in [1, M]$. An answer is YES, if we can pack the A to the L and NO otherwise. All models are the **NP-hard** problems to find the optimal solutions for the arbitrary initial data and are solved in practice as rule using the approximate algorithms. But approximate solutions it is necessary to evaluate somehow. In this case we find the bounds of objective function: a lower bound $LB(A)$ for the tasks "to minimum" and an upper bound $UB(A)$ for the tasks "to maximum". One can write " $UB(A) = approximate\ solution$ " for the tasks "to minimum" and " $LB(A) = approximate\ solution$ " for the tasks "to maximum". Thus, we get $LB(A) \leq OPT(A) \leq UB(A)$ for the both cases. Since $OPT(A)$ is not known, we consider a value $p = ((UB(A) - LB(A))/LB(A)) \cdot 100\%$ as a measure of closeness to $OPT(A)$. In case $p = 0$ we claim "approximate solution = optimal solution". A finding of both fast and quality bounds has a practical importance especially for the tasks of large parameters m (a number of different weights). We offer an estimation technology to form the fast bounds of objective functions for our models. This technology may be used as base to make the bounds of objective functions for the other models that use an idea to divide the initial set A into the disjoint subsets with the given properties. The estimation technology is of two blocks: a reduction block and an estimation content block. The first block removes the dominant groups of weights from the initial data. The second block estimates the existence of reasonable solutions for a given number (M) of subsets. The reduction block lets to lead the initial problem A to a problem A^0 with a property $OPT(A) = OPT(A^0) + OPT(A')$, where $A = A^0 \cup A', A^0 = \bigcup_{i=2}^H A^i, A^i = \bigcup_{j=1}^{M_i} A_j^i, A' = A \setminus A^0$. Each subset A_j^i is a dominate group of i weights. Hence the A^2 is a list of dominate pairs, the A^3 is a list of dominate triplets, the A^4 is a list of dominate quarters and so on. The estimation content block builds a corridor $[C_i^{\min}, C_i^{\max}]$, that any reasonable solution $\{C_i\}$ will pass within $[C_i^{\min}, C_i^{\max}]$, $C_i^{\min} \leq C_i \leq C_i^{\max}, i \in [1, M], C_i \geq C_{i+1}$, the M is a fixed number of bins. Our approach to form the fast bounds of objective functions can be used in practice for the largest parameters m (50000 and more) as an alternative to the other approaches (e.g. a known **LP**-approach with use a **Linear Programming** technique) if a time factor is very important. A program is written in Microsoft Visual C++.

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ABOUT 1-STAGE VOICE MANAGED GEORGIAN INTELLECTUAL COMPUTER SYSTEM

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In the paper we will discuss the main technologic aim of one year subproject "Foundations of Logical Grammar of Georgian Language and its Methodological and Technological Applications" of TSU State Priority Program "Free and Complete Programming Inclusion of a Computer in the Georgian Natural Language System". The final aim of the TSU State Priority Program "Free and Complete Programming Inclusion of a Computer in the Georgian Natural Language System" is a complete

mathematical foundation of Georgian Language and Thinking (GLT) and construction of Basic Georgian Intellectual Computer System, which, in turn, is just a computer equipped with the mathematical theory of GLT. The theoretic purpose of the one year subproject "Foundations of Logical Grammar of Georgian Language and its Methodological and Technological Applications" is to completely represent and fully systematize new sights and results elaborated on the basis of researches pursued with the purposes of creating Mathematical Theory of GLT (MTofGLT). The subproject's technological aim is to construct the first stage Voice Managed Georgian Intellectual Computer System ($VMGICS_1$) through integration of the first stage MTofGLT and Georgian speech recognizer and synthesizer systems, which are already elaborated by our researches. The $VMGICS_1$ is a systemic unit of its basic sub-systems $GWmanager_1$, $GWreader_1$, $Golistener_1$, $GWintel_1$ and non-basic, i.e. produced sub-system $GOintel_1$, which, in turn, is constructed through integration of the basic sub-systems $GWreader_1$, $Golistener_1$, $GWintel_1$. Computer, which will be software by $VMGICS_1$ system allows user to give user-defined standard and nonstandard commands via Georgian voice signal and will be equipped with:

1. Abilities to solve Georgian logical tasks and critically analyze Georgian logical judgments, given by Georgian written and oral languages;
2. Abilities to translate from Georgian written and oral languages into English and German written Languages by using mathematical language as a mediator Language.
3. General thinking abilities in Georgian written and oral languages. It means that these systems equipped computer with abilities to make morphologic, syntactic, logical and common-semantic spell-checking of texts of Georgian written and oral languages. In the same time, it means that the systems equipped computer with abilities to reduce any sentence of core part of Georgian written and oral languages (CPofGWL and CPofGOL) to core part of Georgian thinking language (CPofGTL), and vice versa (i.e. to produce any well-formed expression of CPofGTL in CPofGWL and CPofGOL).
4. Fully content non-sensitive and partially content sensitive reading possibilities in Georgian written language and partially content non-sensitive and partially content sensitive listening possibilities in Georgian oral language.

In the paper we will present in detail 1-Stage Voice Managed Georgian Intellectual Computer System and, also, we will present 1-Stage Logical Grammar of Georgian Language and 1-Stage Voice Recognition and Synthesizer Systems for Georgian as a theoretic grounding of the 1-Stage Voice Managed Georgian Intellectual Computer System.

GEORGIAN LANGUAGES THESIS

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The main purpose of one year subproject "Foundations of Logical Grammar of Georgian Language and its Methodological and Technological Applications" of the TSU State Priority Program is to completely represent and fully systematize new sights and results elaborated on the basis of researches pursued with the purposes of creating Mathematical Theory of GLT (MTofGLT). In the paper we will discuss natural specifics of GLT, which in fact play the main role in our researches and our lingual ideology. It must be noticed that our general views on Language was formed as a result of our

researches and of that general semantic approaches which was developed by Sh. Pkhakadze on the basis of his Notation Theory (NT). General view on a language of Montague, which is based on Frege's artificial mathematical language, differs from the Chomsky's view, who tried to study natural languages in the confines of natural languages. 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 are studying. This is as clear as unfairness of researching one's physical world using elements, which are out of this physical world. In spite of this clear fact, we do not exclude mathematical language from the lingual researches. Though, differently from Montague, we do not consider mathematical language as a separately standing artificial language from the natural languages. Moreover, we think that any natural language and thinking, in its basic part, is founded on Primary Mathematical Language (PML) and Primary Mathematical Concepts (PMC), which naturally exist in any human. Herewith, according to our lingual ideology primary semantic date, universally existing in the human, is the Primary Mathematical Theory (PMT), constructed on the basis of the PML and PMC. It is clear that this PMT subconsciously exists in a human. That is why we call the PML of this PMT as primary natural language of subconscious stage (PNLoSS). We must mention, that one of the basic aim of our researches is full recovering of the Georgian Thinking Language (GTL) and, also, full recovering PML and PMT, which are standing at the grounding level of GTL. Now it should be clear, why we call Frege's artificial mathematical language as a natural language of subconscious level, and natural languages as natural languages of conscious stage. Our researches, which are based on prof. Sh. Pkhakadze's NT and his sufficiently General \mathfrak{S} mathematical language \mathfrak{S}_{SGML} , lead us to declare the following very important statements from ideological as well as from technological point of view, which we call Georgian language Theses:

1. **Georgian Language is a result of formally extension of PML.**
2. **Georgian language is a language of \mathfrak{S}_{SGML} type.**

In this way, according to our lingual ideology we are ready to make following important conclusion:

As it is known, Chomsky was interested not only in complete machine foundation of natural languages, but he also researched universal genetic linguistic program. Also, Montague researched a universal grammar. It is also well known about Wierzbicka's attempts to find universal linguistic concepts. The processes to find so-called linguistic universals always accompany lingual researches: **We think that while we are researching natural languages, it is more important to research various lingual specifics of other natural languages, than to research linguistic universals. Herewith, we say that as linguistic universals may consider only elements of PML, which by its different extensions gives different natural languages.**

MODIFIED $M\tau SR$ THEORY

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We defined contracted symbols and proved main theorems about properties of contracted forms and operations on it in [1]. This results, as well results stated in [2], concludes that I-IV, II' and IV' types of contracted symbols are rational by following meaning:

"On one side System is so general that we can define almost every contracted symbols which is used in classical mathematical theories. On second side System has so rich properties we have guarantee of freedom to do operating on contracted forms." [1]. Therefore in formal and "shinaarsuli" mathematical theories is desired to use I-IV, II and IV' types of contracted symbols. Note that III, IV and IV' types of