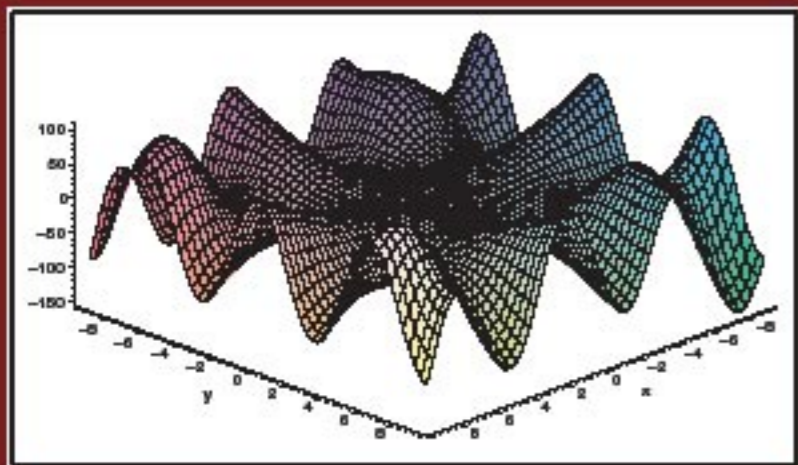


The book represents a library of well-designed software, which well supplements the already available Maple software with the orientation towards the widest circle of the Maple users, greatly enhancing its usability and effectiveness. The current library version contains tools (more than 570 procedures and program modules) that are oriented onto wide enough spheres of computing and information processing. The library is structurally similar to the main Maple library and is supplied with the advanced Help system about the tools located in it. In addition, the library is logically connected with the main Maple library, providing access to the tools contained in it similarly to the package tools. The library will be of special interest above all to those who use Maple of releases 6 - 9/9.5 not only as a highly intellectual calculator but also as environment for programming of different problems in own professional activities. The represented source codes of the library tools, using both the effective and the non-standard technique, can serve as an useful enough practical programming guide on the Maple language.



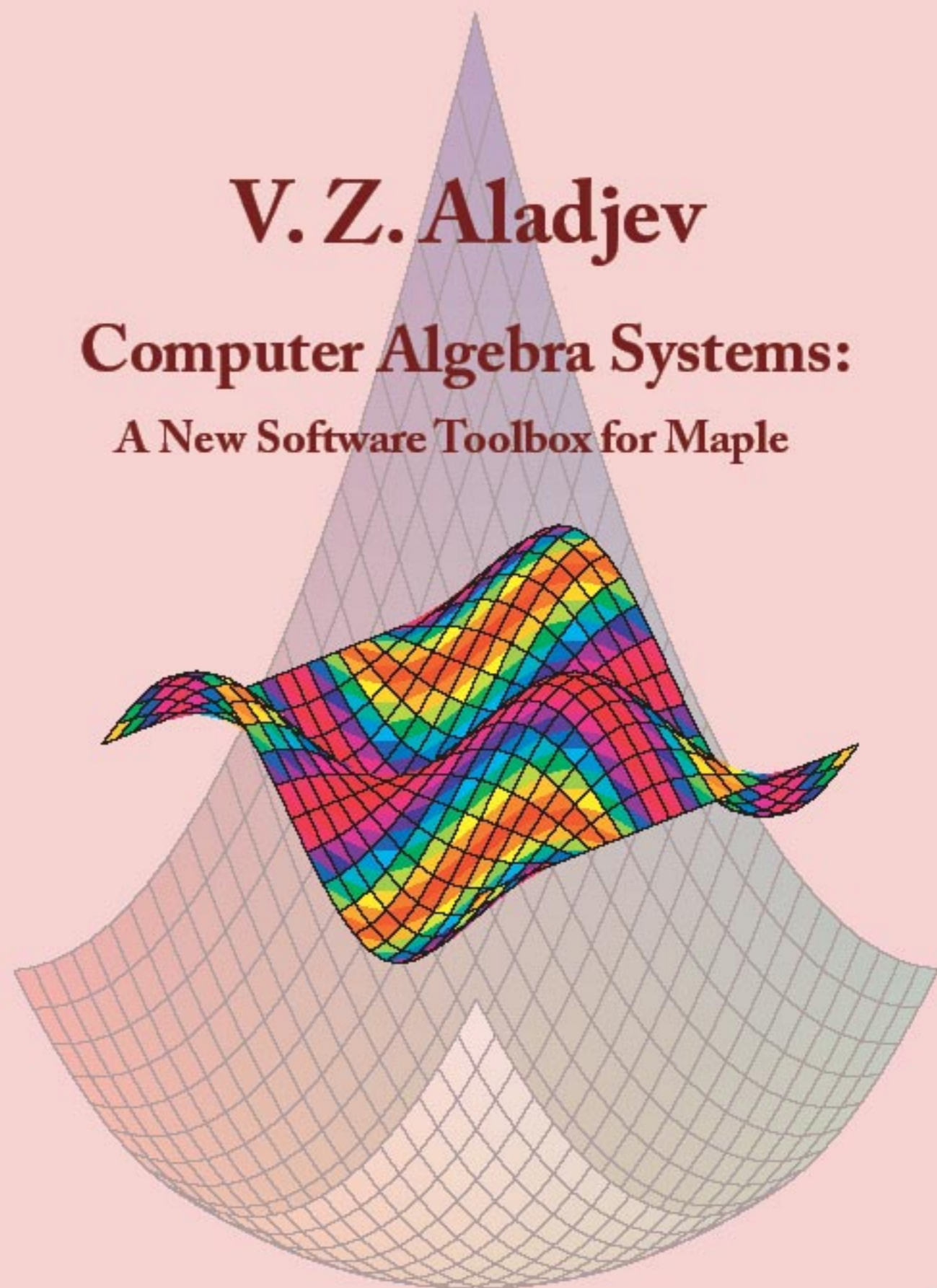
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Professor Aladjev V. was born on June 14, 1942 in the town Grodno (Byelorussia). Now, he is the First vice-president of the International Academy of Noosphere and the president of Tallinn Research Group, whose scientific results have received international recognition, first, in the field of mathematical theory of Cellular Automata (CA). He is member of a series of Russian and International Academies. Aladjev V. is the author of more than 300 scientific publications, including 60 books, published in many countries. He participates as a member of the organizing committee and/or a guest lecturer in many international scientific forums in mathematics and cybernetics.



V. Z. Aladjev ♦ Computer Algebra Systems: A New Software Toolbox for Maple





Computer Algebra Systems: A New Software Toolbox for Maple

by
V. Z. Aladjev

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***This monograph is dedicated to my wife Galina,
daughter Svetlana,
grandsons Arthur and Kristo!***

From the Author

This monograph is a fully revised edition of our previous monographs whose pressrun was completely sold out. The book presents the *Library* for the modern computer algebra system *Maple* of releases 6 – 9.5, extending its basic tools. Source codes of the *Library* tools introduce the reader into both effective and *non-standard* programming technique in the *Maple* package. The reader should have a background in the *Maple* environment of any release.

Alongside with it, the monograph considers a lot of essential disadvantages, defects and errors of the package. In addition, a series of them are eliminated by the facilities represented in the present monograph whereas onto others an accent has been done with the purpose to draw developers attention at creation of new releases of the package. Unfortunately, up till now the old tendency is kept - the new *Maple* releases are not free from many old disadvantages, defects and errors, adding their set by new ones.

The tools represented in the book increase the range and efficiency of use of the *Maple* package on *Windows* platforms 95/98/98SE/ME/NT/XP/2000/2003 owing to the innovations in three basic directions: (1) *elimination of a series of basic defects and shortcomings*, (2) *extending of capabilities of a series of standard tools*, and (3) *replenishment of the package by new means which increase capabilities of its program environment, including the means which improve the level of compatibility of releases 6 – 9/9.5*. The basic attention is devoted to additional tools created in the process of practical use and testing the *Maple* package of releases 4 – 9 which by some parameters extend essentially the opportunities of the package and facilitate the work with it. The considerable attention is also devoted to the means providing package compatibility of releases 6 – 9/9.5. The experience in the use of given software has confirmed its high operational characteristics at the usage of *Maple* in numerous appendices.

The above software has been organized into the user *Library* whose a current version contains tools (more than 570 *procedures* and *program modules*) which are oriented onto wide enough sphere of computing and information processing. The *Library* is structurally similar to the main *Maple* library and is supplied with the advanced Help system about the tools located in it. In addition, the *Library* is logically connected with the main *Maple* library, providing access to the tools contained in it similarly to the package tools. The simple guide describes the installation of the *Library* at presence on PC with one of the *Windows* platforms 95/98/98SE/ME/NT/XP/2000/2003 of the installed *Maple* package of releases 6 – 9/9.5.

The *Library* is designed for a wide audience of experts, teachers, post-graduates and students of natural-science professions who use *Maple* of releases 6 – 9/9.5 on the above *Windows* platforms in their own professional work. The *Library* contains well-designed software (a set of procedures and program modules), which supplements well the already available *Maple* software with the orientation towards the widest circle of the *Maple* users, greatly enhancing its usability and effectiveness. Our experience reveals that the use of the *Library* essentially extends opportunities of *Maple* of releases 6 – 9/9.5, simplifying the programming of various practical problems in its environment. This *Library* will present special interest above all for those who use *Maple* not only as a highly intellectual calculator but also as environment for programming of different problems in one's own professional activity. This book will be interesting for scientists, researchers, candidates for doctor's or master's degree in the field of computer algebra systems, and experts and researchers in other areas of physics and mathematics who use computer algebra systems in own professional

activity. All *Library* tools can be viewed and modified by users. Therefore, it is useful to learn the *Maple* programming language so that you can modify existing *Maple* code to produce customized means. At last, source codes of the *Library* tools introduce the reader into both effective and non-standard programming technique in *Maple*, better revealing subtleties of the *Maple* programming language. All this allows to hope, that the represented book and the software attached to it will appear useful enough to broad audience of the *Maple* users, both for the beginners and the skilled ones.

Archive with the *Library* versions for *Maple* of releases **6, 7, 8** and **9/9.5** additionally contains the set of *mws*-files composing Help database for the *Library* and the set of *mws*-files with the *Maple* documents containing source codes (for series of them, the different implementations are given) of the *Library* tools with examples of them appendices both in usual and especial situations. The archive contains the detailed guide on installation of the *Library* for the above *Maple* releases; in addition, two installation modes are supported - *self-acting* on the basis of special *mws*-document and *manual* by means of simple copying of datafiles (from the unpacked archive into your *Maple* file system). The installed *Library* is logically linked with the main *Maple* library with the higher priority, providing access to all tools contained in it at level of the standard *Maple* tools. At such approach, the appropriate *Library* tools allow both to extend the *Maple* tools of the same name and to eliminate errors contained in them.

Preface

Computer Algebra (also known as *Symbolic Computation* or *Computational Algebra*) has found application in many fields of science such as mathematics, physics, chemistry, computer science, engineering, education, technology, computational biology, etc. The *computer algebra systems* (CAS) such as *Maple*, *Reduce*, *MuPAD*, *Axiom*, *Macsyma*, *Mathematica*, *Derive*, *Magma*, and others are becoming more and more popular in teaching, research and industry. The area of symbolic and algebraic computation aims at automation of mathematical computations of all sorts. The resulting computer systems, both experimental and commercial, are powerful tools for scientists, engineers, and educators. This research combines mathematics with advanced computing techniques. CAS is an interdisciplinary area between *Mathematics* and *Computer Science*. Its research focuses on the development of algorithms for performing *symbolic* manipulations with algebraic objects on computers, and design of programming languages and environments for implementing these algorithms.

In a series of our books and papers [1-20,33,39,41-45,47,48], such packages as *Maple*, *Reduce*, *MathCAD* and *Mathematica* have been considered. Our experience in the detailed testing and practical use of different mathematical and physical applications of four mathematical packages (*Reduce*, *Maple*, *MathCAD* and *Mathematica*) enables us to consider the packages *Maple* and *Mathematica* as undoubted leaders (*on the basis of a generalized index*) among all listed modern tools of computer algebra. Meanwhile, we give preference to the package *Maple* due to a number of strong reasons described in the above books enough in detail.

Computer algebra becomes a rather powerful and useful tool for scientists and experts from various fields. However, manifold applications demand that the essential significant numerical calculations be combined with algebraic ones. With each new release, the package *Maple* meets more and more requirements. The *Maple* package has been widely used not only as a tool of solving mathematical problems. The package allows us to revise approaches to teaching subjects related to mathematics in universities by defining in many cases the methods for a teaching of subjects with the use of PCs to solve mathematical problems for various purposes [11-14,20-28,32,34-36,40-42].

Researchers use well-known *Maple* package as an essential tool when solving problems related to their investigation. The package is ideal for formulating, solving, and exploring different mathematical models. Its symbolic manipulation facilities extend greatly over a range of problems that can be solved with its help. Educators in high schools, colleges, and universities have revitalized traditional curricula by introducing problems and exercises, which use *Maple's* interactive mathematics and physics. Students can concentrate on the more fundamental concepts rather than on tedious algebraic manipulations. Finally, engineers and experts in industries use *Maple* as an efficient tool replacing many traditional resources such as reference books, calculators, spreadsheets and programming languages. These users easily solve mathematical problems, creating projects and consolidating their computations into professional reports.

Maple products embody advanced technologies such as symbolic computation, infinite precision numeric, innovative *Web* components, extensible user-interface technology, and an unrivalled suite of mathematical algorithms for intelligent management of complex mathematics. Over 3 million users benefit from advanced *Maple* technology. Virtually, all major universities and research institutes in the world, including such as MIT, Oxford, Stanford and Waterloo, has adopted *Maple*

products to enhance their education and research activities. Waterloo *Maple's* industrial customer base includes Boeing, Bosch, Canon, NASA, etc.

Meanwhile, our operational experience in the period of 1997 – 2004 with *Maple* of releases 4, 5, 6, 7, 8 and 9/9.5 enabled us not only to estimate its advantages compared with other similar mathematical packages, but has also revealed a number of faults and shortcomings which were eliminated by us. Furthermore, *Maple* does not support a number of important procedures of information processing, *symbolic* and *numeric* computing, including the tools of access to datafiles. By operating *Maple* we have developed rather effective tools (*procedures* and *program modules*), largely extending the possibilities of the package. This software has been organized as a *Library* that is structurally similar to the main *Maple* library, and is provided with a rather detailed Help system analogous to *Maple* Help system.

In particular, *Maple* does not provide sufficient compatibility of releases 6, 7, 8 and 9. This fact and the incompatibility of the package found out by us at a level of base platforms – *Windows* 98SE and lower, on the one hand, and *Windows* XP and above, on the other hand, the decision of a compatibility problem for the *Library* means have demanded.

The tools represented in the *Library* increase the range and efficiency of use of the package on the *Windows* platform owing to the innovations in three basic directions: (1) *elimination of a series of basic defects and shortcomings*, (2) *extension of capabilities of a series of standard tools*, and (3) *replenishment of the package by new means which increase the capabilities of its program environment, including the facilities improving the compatibility of releases 6, 7, 8 and 9/9.5*. The basic attention is devoted to additional tools created in the process of practical use and testing of the package of releases 4 – 8 which by some parameters considerably extend the capabilities of the package making the work with it much easier; a considerable attention is also devoted to the tools providing package compatibility of releases 6, 7, 8 and 9/9.5. The experience in using the above software for various applications has confirmed its valuable operational characteristics.

It should be noted that a series of our books and papers on *Maple* [11,13-20,22-25,30-33,39,43-45,47], representing tools developed by the authors and containing suggestions on further development of the package encouraged the development of such applications as package modules *FileTools*, *LibraryTools*, *ListTools* and *StringTools*. However, the means suggested by us essentially extend the capabilities of the package, which in many cases exceed those of the specified modules.

The above software has been organized into the user *Library*, whose a current version contains tools (more than 570 *procedures* and *program modules*) which are oriented to a wide area of computing and information processing. The *Library* is structurally similar to the main *Maple* library and is supplied with the advanced Help system about the tools located in it. In addition, it is logically connected with the main *Maple* library, providing access to the tools contained in it similarly to the package tools. The simple guide describes the installation of the *Library* at presence in the PC with the above-mentioned *Windows* platform of the installed *Maple* package of releases 6, 7, 8 or 9/9.5.

The package incompatibility found by us as at the level of its releases, and at the level of underlying platforms – *Windows* 98SE and lower, on the one hand, and *Windows* XP and above, on the other hand, shows need for solving a compatibility problem of for the *Library* tools. A current *Library* version contains means (*more than 570 procedures and program modules*), oriented onto the following basic kinds of processing and calculations:

1. General purpose software
2. Software for operation with procedural and modular objects of *Maple*
3. Software for operation with numeric expressions

4. Software for operation with strings and symbolic expressions
5. Software for operation with sets, tables and lists
6. Software to support data structures of a special type
7. Software to support bit-by-bit processing of symbolic information
8. Tools extending graphic possibilities of *Maple* of releases 6 – 9.5
9. Tools that extend and improve the standard tools of *Maple*
10. Software for working with *Maple* datafiles and documents
 - 10.1. General purpose software
 - 10.2. Software for operation with *TEXT* datafiles
 - 10.3. Software for operation with *BINARY* datafiles
 - 10.4. Software for operation with *Maple* files
 - 10.5. Some special tools for operation with datafiles
11. Software for solving problems of mathematical analysis
12. Software for solving problems of linear algebra
 - 12.1. General purpose software
 - 12.2. Software for operation with *rtable*-objects
13. Software to support simple statistics problems
 - 13.1. Software for solving problems of descriptive statistics
 - 13.2. Software for solving problems of regression analysis
 - 13.3. Software for testing of statistical hypotheses
 - 13.4. Elements for simple analysis of time (*dynamic*) and variation series
14. Software for operation with the user libraries

The basic innovations of our *Library* with respect of the listed sections that thematically classify the *Library* tools can be briefly characterized as follows (*in brackets, quantity of corresponding procedures is given*):

1. General pupose softare **(15)**:
 - Inceaseng comatibility of *Maple* of releases 6 – 9/9.5 concerning its standard functions *{'assign', 'close', 'fclose', 'fremove'}*;
 - definition of full paths to the basic subdirectories of the package *Maple*;
 - definition of installed releases of the package *Maple* on your computer;
 - definition of the current release of the package *Maple*;
 - definition of the current version of underlying operational system of a computer, etc.
2. Software for operation with procedural and modular objects of *Maple* **(30)**:
 - output of source code of a program module or package and variables exported by them;
 - a simple method of procedures debugging based on the basis of a method of checkpoints;

- checking the availability in datafiles of the specified procedures and program modules;
 - checking the datafiles for presence of incorrect program modules;
 - checking the type of a module table;
 - dynamic call of the variables exported by a program module;
 - checking the availability in a current *Maple* session of the specified procedures, modules or variables;
 - definition of formal arguments of a procedure, a program module or package;
 - checking onto compatibility of files of type {"**.m**", "**.lib**"} with the current release of *Maple*;
 - merging of datafiles created by the standard *Maple* function '*save*';
 - converting of a program module into equivalent procedure;
 - converting of program modules of the *second* type into equivalent modules of the *first* type;
 - extraction of procedures and program modules from text datafiles;
 - converting of files of the input *Maple* language format into the internal *Maple* format, and vice versa;
 - converting of any *Maple*-object into the program module, etc.
3. Software for operation with numeric expressions (**10**):
- converting of the floating-point numbers into the stylized standard format;
 - an useful special converting of integers into the list, and vice versa;
 - converting of the numbers presented in a symbolical or string format, into numerical values, etc.
4. Software for operation with strings and symbolic expressions (**57**):
- extraction of *Maple* expressions from their symbolical or string representations;
 - a special converting of strings or symbolical expressions containing *blanks*, for an opportunity of their subsequent correct use by the standard *Maple* functions {'*system*', '*ssystem*'}.
 - a set of tools to remove strings and symbolic expressions of their components;
 - a set of tools for an analysis of contents of strings and symbolic expressions;
 - the expanded set of tools for converting of strings and symbolical expressions into lists, vectors and numerical values, and vice versa;
 - the expanded search for the patterns containing *wildcard*-symbols;
 - special insertions of symbols into strings and symbolic expressions;
 - definition of multiple entries into strings, symbolic expressions and lists;
 - special methods of searching for strings and symbolic expressions;
 - reducing to the specified multiplicity of entries of symbols or substrings into a string;
 - extraction from strings and symbolical expressions of substrings limited to the specified delimiters;

- the extended set of tools for substitutions into strings and symbolical expressions;
 - the extended set of searching tools to in strings and symbolical expressions;
 - the extended set of tools for sorting the elements of strings, symbolic expressions and lists;
 - simple tools for coding / decoding of text information, etc.
5. Software for operation with sets, tables and lists (57):
- support of a special algebra with lists and scalars;
 - support of the set-theory operations with lists;
 - special conversions of lists into sets, and vice versa;
 - tools for expansion of sets and lists, and subsequent elements rearrangements;
 - the extended means for substitutions into lists and sets;
 - a set of special facilities for operation with lists and sets;
 - the extended means of analysis of multiple entries of elements into lists;
 - special conversions of lists into vectors;
 - definition of indices of a table by its entry, and the analysis of multiplicity of its entries;
 - removing elements from tables, and providing the output of a table graph with numerical entries;
 - a representation of special kinds of tables;
 - extension of the standard function '*map*' onto lists, tables and sets;
 - tools for sorting ordinary and nested lists;
 - dynamic assignment of expressions to elements of a list or set;
 - a converting of tables into lists, and vice versa;
 - reduction of entries into a list of multiple elements, etc.
6. Software to support data structures of a special type (20):
- support of a new data structure of *dirax*-type of direct access;
 - an extension of the standard function '*type*' by a new *dirax*-type, and conversion of its algorithm of check onto *heap*-type;
 - tools for reorganization of data structures of various types $\{stack, queue, heap\}$;
 - the extended check of a *Maple* object onto type $\{dirax, list, table, heap, stack, queue\}$, etc.
7. Software to support bit-by-bit processing of symbolic information (7):
- the above tools are not available in all current releases of the package *Maple*, therefore these means of the *Library* are both rather pertinent, and applicable for a wide range of applications. A number of useful procedures created on their basis are represented.
8. Tools extending graphic possibilities of *Maple* of releases 6 - 9.5 (16):
- a dynamic coloring of frames of the animated 2D-graphs. For support of the dynamics the method of "*disk transits*", a rather useful in the advanced programming in the *Maple* environment is used;

- an extension of the standard functions '*animate*' and '*animate3d*' onto any quantity of parameters of animation. For maintenance of dynamics the method of "*disk transits*", rather useful in conditions of advanced programming in *Maple* is used. The given method has been developed by us and successfully used for computers of 3rd generation (IBM/360, IBM/370, etc.) and appeared especially effective with appearance of the personal computers whose development is characterized (including) by enough quick decreasing of time of access to external memory on hard disks;
 - an extension of the standard functions '*smartplot*' and '*smartplot3d*', etc.
9. Tools that extend and improve the standard tools of *Maple* (86):
- checking the type of expressions, active in a current *Maple* session;
 - essential extensions of the standard functions '*map*', '*map2*', '*op*', '*read*', '*save*', '*seq*', '*curry*' and '*rcurry*';
 - an essential extension of the standard function '*assign*' with elimination of its incompatibility concerning releases 6 – 9.5 of the package *Maple*;
 - an expansion of the standard operators '*and*', '*or*' and '*xor*' onto any quantity of operands;
 - converting the expressions sequence into string, and checking an expression onto type '*expressions sequence*';
 - an extension of the standard function '*type*' onto such types as '*binary*', '*nestlist*', '*boolproc*', '*dir*', '*file*', '*path*', '*byte*', '*digit*', '*letter*', '*ssign*', '*mod1*', '*package*', '*sequent*', '*setset*', '*realnum*', '*upper*', '*Upper*', '*lower*', '*Lower*';
 - an expansion of the standard function '*member*' for checking if an expression belongs to a set, range, string, symbolical expression, list, module, table, procedure, array and *rtable*-object;
 - an useful extension of the standard function '*convert*';
 - checking *Maple* expressions onto *emptiness*;
 - elimination of certain defects of the standard function '*evalf*';
 - means of increasing the compatibility of releases 6 – 9.5 of the package *Maple*, etc.
10. Software for working with *Maple* datafiles and documents (151)
- 10.1. General purpose software (80):
- deletion of datafiles having an any set of attributes;
 - testing of datafiles, logic input/output channels and input/output devices;
 - dynamic increase of quantity of accessible logic input/output channels;
 - the extended means of closing of all open datafiles and logic input/output channels of a current *Maple* session;
 - definition of components composing a filename or full path to it;
 - a standardization of path to a datafile or directory that allows to correctly use them by the standard functions {'*system*', '*ssystem*'};
 - opening of the same datafile on the different logic input/output channels;

- searching for datafiles with *Maple* documents containing the specified context;
- checking of datafiles and directories onto *emptiness*, copying of one catalogue into another;
- renaming of directories and datafiles with retention of their attributes;
- the extended checking of properties of directories and datafiles;
- checking of datafiles types concerning extensions of their names and logical organization {*TEXT*, *BINARY*};
- an extension of the standard function '*type*' onto a new *rlb*-type of datafiles;
- an extension of the standard function '*convert*' providing conversion of an arbitrary datafile into a datafile of type {*rlb*, *TEXT*};
- definition and redefinition of attributes of datafiles and directories;
- checking datafiles onto a mode of their opening;
- checking of a logic input/output channel for the specified open datafile; opening of a datafile on the specified logic input/output channel;
- essential extensions of the standard functions '*currentdir*', '*fopen*', '*open*', '*mkdir*' and '*rmdir*';
- creation of a chain of directories of any nesting level or an *empty* closed datafile, full path to which has been specified by a chain of subdirectories of any nesting level;
- creation of an accessible *empty* target datafile, etc.

10.2. Software for operation with *TEXT* datafiles (32):

- an essential extension of the standard functions '*writedata*' and '*readdata*';
- tools of providing of direct access to datafiles of the *TEXT*-type;
- tools of extended processing of datafiles of the *TEXT*-type providing a number of mass operations with text datafiles, etc.

10.3. Software for operation with *BINARY* datafiles (12):

- an effective processing of a situation «*the end of a datafile*»;
- tools for extended processing of datafiles of the *BINARY*-type providing a number of mass operations with binary datafiles, etc.

10.4. Software for operation with *Maple* files (12):

- a special re-structuring of a text datafile created by the standard function '*save*';
- checking the availability of a datafile for reading by the standard function '*read*';
- providing of compatibility of a datafile of the internal *Maple* format with the current *Maple* release;
- checking the types of all datafiles of the specified directory;
- removal of all results of calculations from the specified *mws*-file;
- calculation of the attribute determining name length of a *Maple* object in files of the internal *Maple* format;
- definition of presence in *mws*-files of links and their types, etc.

10.5. Some special tools for operation with datafiles **(15)**:

- selection of correct *email*-addresses out of datafiles of the ASCII-format;
- a coding / decoding of datafiles of the ASCII-format;
- selection out of a datafile of words satisfying to the specified conditions;
- providing of support of the mechanism of "*disk transits*";
- a specific statistical analysis of text datafiles and strings, etc.

11. Software for solving problems of mathematical analysis **(15)**:

- extension of the *shift*-operator onto any quantity of leading variables;
- calculation of values of the tabulated functions;
- calculation of partial derivatives in the specified points;
- full integration of algebraic expressions;
- a polynomial data interpolation;
- a dynamic generation of linear constraints for optimization problems;
- calculation of independent variables of algebraic expressions;
- an analysis of algebraic expressions or functions from one independent variable;
- searching for a minimax of algebraic expressions, etc.

12. Software for solving problems of linear algebra **(24)**

12.1. General purpose software **(10)**:

- an interactive creation of numerical rectangular matrixes;
- full factorization of a polynomial from one leading variable;
- an useful special sorting of matrixes of types *Maple* and *NAG*;
- a dynamic generation of cyclic constructions "**for_do**" and "**seq**" of any nesting level;
- an extension of the standard function '*type*' onto check of types of indices and entries of tables, etc.

12.2. Software for operation with *rtable*-objects **(14)**:

- the extended converting of *Maple*-objects into *NAG*-objects, and vice versa;
- checking *rtable*-objects, active in a current *Maple* session;
- checking identification numbers of the active *rtable*-objects;
- checking the saving of the active *rtable*-objects in a current *Maple* session;
- checking the availability of *rtable*-objects in *mws*-files with *Maple* documents;
- converting of the *mws*-files containing *rtable*-objects;
- restoration of a work history with *rtable*-objects in the previous *Maple* sessions, etc.

13. Software to support simple statistics problems **(32)**:

- checking of a view of distribution generated by the built-in generator '**rand**' of pseudo-random integers;

- a statistical analysis of text datafiles;
- operations with the weighed statistical data;
- creation of single-factor linear and nonlinear models of regression for the specified resultant and factor variables with calculation of the correlation relation and of correlation coefficient, and with graphic representation of both the initial data, and the model of regress on the same 2D-graph;
- parametric (*Fisher* and *Student*) and nonparametric (*Van der Waerden* and *Mann-Whitney*) criteria of checking of the *null*-hypothesis of equality of populations variances;
- elements of the simple analysis of time and variation series, etc.

14. Software for operation with the user libraries **(46)**:

- checking of a *Maple* object to be a library similar to the main library of the package;
- selective call of procedures, modules and variables from the specified libraries;
- maintenance of the simple user libraries structurally distinct from the main *Maple* library;
- the extended means of maintenance of the libraries similar to the main *Maple* library;
- an effective method of a saving of procedures and program modules in libraries;
- facilities for operation with the damaged libraries similar to the main *Maple* library;
- the extended gathering of statistics on use of library tools, etc.

Taking into account our long-term experience in operation with the *Maple* package of releases 4 – 9.5 and experience of our colleagues from universities and the academic institutes of Lithuania, Latvia, Belarus, Estonia and Russia, it is should be noted, that many of tools (*or their analogues*) of our *Library* are worth to be included into standard deliveries of subsequent *Maple* releases. At present, they are accessible to the *Maple* users as the offered *Library* supporting releases 6 – 9 and functioning on platforms *Windows* 95 and later. *Library* tools in many cases allow us to facilitate programming of various applied problems in the *Maple* environment of releases 6 – 9.5.

It is possible to state, that a series of our books on the *Maple* problems [30-33,39,43-45,47] that represent the means developed by us and contain useful tips on the further development of the package, has encouraged the development of package modules *FileTools*, *LibraryTools*, *ListTools* and *StringTools*. However, in this respect tools represented by us essentially extend capabilities of the package, exceeding those of the specified package modules in many cases.

The *Library* is designed for a wide audience of experts, teachers, post-graduates and students of natural-science professions who use *Maple* of releases 6 – 9.5 on *Windows* platform in their own professional work. The *Library* contains well-designed software (*a set of procedures and program modules*), which supplements well the already available *Maple* software with the orientation towards the widest circle of the *Maple* users, greatly enhancing its usability and effectiveness. Our experience reveals that the use of *Library* provides more opportunities of *Maple* of releases 6 – 9.5, simplifying the programming of various practical problems in its environment. This *Library* will be of special interest above all to those *who* use *Maple* not only as a highly intellectual calculator but also as environment for programming of different problems in their professional activities. The *Library* has been rewarded by "Smart Award" from Smart DownLoads Network.

Furthermore, the presence in the *Library* delivery of the text datafile "ProcUser.txt" with source codes of the *Library* software and *mws*-files with help-pages composing Help database of the *Library*

allows us to adapt it to other underlying platforms different from *Windows*. Furthermore, the source codes, using both the effective and the non-standard technique, can serve as an useful enough practical programming guide on the *Maple* language.

In conclusion of the given preamble we shall rather briefly state, addressing to our numerous readers both hereby, and the future ones, the personal opinion on a comparative rating of packages *Maple* and *Mathematica*. Both one and another package have numerous mistakes (*in many cases absolutely inadmissible ones for systems of a similar sort*) to elimination of which developers both *Waterloo Maple* and *Wolfram Research* pays rather small attention. Of commercial reasons unreasonably often are issued the new releases saving former mistakes and containing in a series of cases various exotic luxuries. However, if *Maple* developers in a form of open dialogue with users in any measure try to solve the given problem, the *Wolfram Research* an enough painfully perceives any criticism (*in overwhelming majority a well-founded*) about own product.

On the other hand, *Wolfram Research* conducts rather aggressive marketing politics completely inadequate to quality of its products. That, first of all, explains its temporary quantitative advantages that quickly enough decrease. Comparing responses of users of *Maple* and *Mathematica*, it is possible to ascertain quite unequivocally, that the second ones at use of the package have essentially more problems. If *Waterloo Maple* can improve the marketing politics, it can change essentially a situation on the market of systems of computer algebra and will play a positive role for the given field of modern computer science in view of the more perspective *Maple* technology. In this respect, certain contribution to affair of popularization of the *Maple* was brought also by a series [8-20,22-33,39,41-45,47,48] of our books and papers in *Russian* and *English* against five books on *Mathematica* [1-3,6,7]. Whereas our above-mentioned *Library* allows to expand first of all basic tools of the package *Maple* of releases since the *sixth* one. Furthermore, very expediently a series of tools out of the *Library* to include in a set of standard basic tools of *Maple*, above all, tools such as for operation with file system of a computer, for support of new data types, for operation with program modules, for increase of compatibility level of the releases of *Maple*, etc. Many of the *Library* tools have shown oneself as effective enough means at problems solving in the various fields, by providing in a series of cases a simplification of programming in *Maple*.

The experience gained by the authors in operating and testing of both packages shows that the *Maple* is essentially a more friendly and open system which uses built-in C-like language simplifying employment of the package by the user improving his skills in programming. Whereas *Mathematica* has a little bit archaic and not so graceful language which in many respects is distinct from popular programming languages. Finally, the *Maple* has the more advanced tools (*for example, for solving differential equations with partial derivatives, for developing algorithms for solving the problems, etc.*), providing a wide spectrum of applications in many fields.

Summing up (*in more details a comparative analysis of both packages can be found in our above-mentioned previous books and papers*), we can recommend to the beginner user of systems of computer algebra, the *Maple* package as the most perspective tool in this area of computer science. This is essentially caused also by creative alliance *Waterloo Maple* with the world famous developer of mathematical software – *NAG Ltd*. Moreover, the given package constantly wins back positions of *Mathematica* and starts to dominate in education what is rather essential with orientation toward future prospect.

At last, here pertinently to make a series of important remarks, keeping force during all subsequent statement. Above all, the library whose tools are described below is intended for *Maple* of releases from the 6 to the 9.5 inclusive on operational platforms *Windows 95/98/ME/XP/NT/2000/2003*. However, in the presence of source codes of all these tools in the body text of the book and in electronic form in the attached library the user can enough easily adapt their wholly or selectively

on other operational platform. Along with that, the source codes can serve as an enough well praxis at mastering of programming in the *Maple* environment. Many of source codes represented in the book contain both the effective and the non-standard programming technique that are useful both for the beginners and for the experienced *Maple* users.

Our experience of the package use of releases 4 – 9/9.5 on the different operational platforms *Windows 95/98/ME/XP/NT/2000/2003* speaks about its rather unstable performance relative to the host operating systems and its incompatibility on a series of its basic functional means relative to the releases. These problems are enough widely discussed in our previous books [29-33,43,44]. In particular, at installing of *Maple* of release 8 on platform *Windows 98SE* one of the main package directory receives name “BIN.W9X”, whereas for platform *Windows XP Pro* it will has name “BIN.WIN”. A reasonable explanation to that fact to find difficultly enough. At the same time, in particular, infringement of similar type of standardization at the organization of a file structure of the package complicates some questions of programming with its use.

In a series of problems dealing with datafiles processing takes place one essential functional incompatibility of *Maple* relative to host operating systems, namely. On platforms *Windows 95/98/98SE/ME*, the access to an idle disk drive in the *Maple* environment of releases 6 – 9 invokes the appropriate erroneous situation that can be handled by the package tools, for example by means of ``try`` clause of the *Maple* language. This mechanism is rather convenient and effective means for goals of such kind.

However, on platforms *Windows XP/NT/2000/2003* the above-mentioned access to an idle disk drive can initiate the especial situations with diagnostics “**Mserver.exe** – No disk: There is no disk in the drive. Please insert a disk into drive **X** ...”, where **X** – logical name of the first idle disk drive on the computer. The request demands one of three answers, namely: *Cancel*, *Try Again* or *Continue*. In this case you must answer ``Cancel`` or ``Continue``. The given circumstance causes rather essential inconveniences in many cases. For example, result of the procedure calls ``currentdir`` with the purpose of redefinition of a current directory (*on condition that disk drives “A” and “D” are idle*) cause the following erroneous situations and the above especial situation:

```
> currentdir("A:\\");
```

```
“Mserver.exe – No disk: There is no disk in the drive. ...”
```

```
Error, (in currentdir) file or directory does not exist
```

```
> currentdir("D:\\");
```

```
“Mserver.exe – No disk: There is no disk in the drive. ...”
```

```
Error, (in currentdir) permission denied
```

Meantime, our experience recommends for elimination of the above especial situation at running of *Maple* on platforms *Windows XP/NT/2000/2003* to insert in idle drives any volumes (CD and/or diskette). The trick allows you to get rid of appearance of the above especial situation.

At last, at *Maple* loading (*starting with the seventh release*) on a computer connected to Internet and presence of a Firewall, for example “Zone Alarm”, *Maple* will demand to give access to Internet. At rejection of access, *Maple* is being closed. In our opinion, this is certain infringement of the user rights, related with ensuring of protection of his information. In order to prevent possible undesirable consequences (*Spyware*, etc.) before the *Maple* loading, we recommend to execute one of the following procedures:

(1) to disconnect Internet and to enable access to it upon inquiry of your Firewall;

(2) to disconnect Internet and Firewall.

It is completely insignificant loss, since performance capabilities of *Maple* (at least now) in Internet environment are rather limited. Some other remarks and suggestion on the *Maple* use will be presented during the statement.

In summary, it is necessary to note a rather strange tendency to deterioration of some characteristics (as a whole of rather perspective package) from release to a release; about that testifies as our six-year experience of approbation and use of the package of releases **4 - 9**, and results of similar work of a plenty of the *Maple* users in various applied physical and mathematical appendices. Apparently, it would be necessary to speed up not delivery on the market of new releases of the package (*when between releases elapses about a year*), but its versions eliminating the noticed shortcomings (*passing from the version to the version and from release to a release*) and extending possibilities of the most frequently used means instead of adding new releases by additional means that are often sometimes uninteresting, undeveloped and erroneous ones. In the given direction have been undertaken as our efforts, and efforts of a lot of other *Maple* users. The represented monograph summarises our results in the given direction.

However till now, many of basic remarks and suggestion have not found reflection in last releases of the package. Confirming the told, we shall cite only one simple example of incorrect calculation by the *sum*-function of the package, namely:

> m:= 'm': sum((-m)^n, n = 0 .. infinity); -> 1/(m + 1)

In this example the *sum*-function returns result on the basis of the following relation:

$$\lim ((-m)^p * m + 1) / (m + 1) \text{ for } p \rightarrow \infty$$

by assuming values $m < 1$ or $p < 0$, whereas *m*-variable has indeterminate value. And it takes place during all releases **5 - 9**. Along with the marked disadvantages, *Maple* is burdened by a lot of other essential disadvantages which procure to the users many inconveniences and demand the primary attention on the part of developers of a package. On the other hand, the package, since 7-th release, as the extension, has received the **Sockets** module intended for creation of the *Maple* appendices for operation in networks of the TCP/IP-protocol. However, its means are rather primitive for serious appendices.

All this grows out from not entirely thought-out strategy of developers and the raised haste to please market situation that at creation of complex scientific packages is not pertinent and can lead to absolutely opposite results. Meanwhile, in spite of the told, in our opinion, *Maple* up till now continues to remain one of the leaders among modern systems of computer algebra; however, its further destiny in many respects will depend on the strategy chosen by the developers. Unfortunately, existing tendencies yet no especially give hope - intervals between new releases diminish, whereas many essential shortcomings and mistakes are not eliminated. The quantity of censures grows on the part of the *Maple* users.

Chapter 7.

Software to support bit-by-bit processing of symbolic information

In the seventh section, the tools, which support a *bit-by-bit* information processing in the *Maple* environment, are represented. The package does not possess tools of the similar type. The software offered by us is represented by six useful procedures such as **Bit**, **Bit1**, **xbyte**, **xbyte1**, **xNB** and **xpack**. These procedures serve for *bit-by-bit* information processing, i.e. the user has a possibility to operate with strings or symbols at a level of separate bits composing them.

Bit – bit-by-bit information processing

Bit1

xbyte

xbyte1

xNB

Call format of the procedures:

Bit(**B**, *bits*)

Bit1(**B1**, *bits*)

xbyte(**L**)

xbyte1(**L1**)

xNB(**N**)

Formal arguments of the procedures:

B – a symbol or a string of length **1**, or an integer **1**-element list

B1 – an integer from the range **0..255**

bits – a leading variable of a polynomial

L – a list from **8** binary digits

L1 – a positive binary number of length ≤ 8 , or a list from no more than **8** binary digits

N – a positive integer (*posint*)

Description of the procedures:

The tools represented below serve for a *bit-by-bit* information processing, i.e. the user has a possibility to operate with the symbols or strings on a level of separate bits composing them. The first **Bit** procedure allows effectively enough to execute *bit-by-bit* processing of separate symbols.

The procedure call **Bit**(**B**, *bits*) allows to execute the following basic *bit-by-bit* operations with a symbol, defined by the first actual **B** argument of the procedure (as argument can appear an one-element string or symbol of length **1**, and also 1-element list whose element defines a decimal code of a symbol from the range **0 .. 255**):

- (1) if the second actual *bits* argument has a view [**n1, n2, ...**], then the procedure call **Bit(B, bits)** returns the values of bits of symbol **B**, which are located in its **n_j** positions (**n_j** belong to the range 1..8);
- (2) if the second actual *bits* argument has a view [**n1=b1, n2=b2,...**], the decimal code of a symbol, obtained by replacement of values of bits of symbol **B** (which are in its positions **n_k**) onto binary values **b_k**, is returned (**n_k = 1 .. 8; b_k = {0|1}**).
- (3) if the second actual *bits* argument is a name of procedure defined over the lists, the result of application of the procedure to a list of values of all bits of a symbol, defined by the first actual **B** argument, is returned.

In addition, in two last cases the decimal code of a symbol – of the result of processing of the initial symbol, defined by the first actual **B** argument of the procedure, is returned.

The **Bit1(B1, bits)** procedure is a modification of the above **Bit** procedure. In the procedure the more effective algorithm of evaluations has been implemented, however a handling of special and erroneous situations are not fulfilled, and as the first actual **B1** argument only the decimal code of a symbol subjected to bit-by-bit processing is admitted. The second *bits* argument has remained the same. The given procedure is more reactive and can be successfully used in the cyclic computational constructions.

For providing of *bit-by-bit* symbolic processing two basic procedures **Bit** and **Bit1** represented above are intended. The simple procedure **xbyte(L)** fulfills an inverse function, returning a symbol with the given bit value defined by the actual **L** argument; as a value for actual **L** argument a list from 8 binary digits is used.

Provided that the arbitrary symbol "X" has a *bit-by-bit* representation **B::list(binary)**, for the procedures **xbyte** and **Bit** the following defining relations take place:

$$\text{"X"} = \text{xbyte}(\text{Bit}(\text{"X"}, [\text{k}\$\text{k}=1..8])) \quad \text{Bit}(\text{xbyte}(\text{B}), [\text{k}\$\text{k}=1..8]) = \text{B}$$

The procedure **xbyte1(L)** extends the above procedure **xbyte** onto positive binary numbers, i.e. the numbers consisting of numerals {0,1} only; for example **11001011**. In this case we can represent a symbol in the form of such binary number of length, not greater than 8; at a smaller length the procedure supplements a *bit-by-bit* representation at the left by zeroes. Moreover, a binary list of length < 8, obtained at the procedure call, is supplemented at the left by zeroes up to the standard list of length 8. Such approach allows in many cases more conveniently to represent the symbols at a level of bits composing them.

The simple procedure **xNB(N)** has been implemented by a one-string extracode and is useful enough at operation with information at the bit level. The procedure call **xNB(N)** returns the *true* value, if a positive integer **N** consists of binary numerals only, otherwise the *false* value is returned. The five procedures **Bit**, **Bit1**, **xbyte**, **xbyte1** and **xNB**, represented above, along with the introduced types {*digit, binary, byte*} create a quite satisfactory basis for operation with symbolic information at the *bit-by-bit* level. The examples represented below illustrate use of all procedures represented above for a *bit-by-bit* information processing in the *Maple* environment.

```

Bit:= proc(B::{string, symbol, list(integer)}, bits::{procedure, list(equation), list(posint)})
local a, b, c, d, h, k, R;
  assign(c = "00000000"), `if` (type(bits, procedure), goto(Evaluation), `if` (member(B, {`0`, "0"}),
    [assign(b = ""), goto(Art)], assign(a = {k $ (k = 1 .. 8)}, h = {[k] $ (k = 1 .. 8)})),
  `if` (type(B, list) and nops(B) = 1 and member(op(B), {k $ (k = 0..255)}) and nops(bits) <= 8,
    goto(Kr), `if` (type(B, {name,string}) and length(B)=1 and nops(bits)<=8, goto(Kr), goto(E)));

```

```

Kr;
`if (type(bits, list(posint)) and {op(bits)} union a = a or type(bits, list(`=)) and
  {entries(table(bits))} union {[1], [0]} = {[1], [0]} and {indices(table(bits))} union h = h,
  goto(Evaluation), goto(Error2));
E;
ERROR("invalid arguments <%1> or/and 2nd argument <%2>", B, bits);
Error2;
ERROR("invalid 2nd argument <%1>", bits);
Evaluation;
b := cat("", convert(op(`if` (type(B, list), B, convert(cat("", B), bytes))), binary));
Art;
R:= L::list -> convert(SN(cat("", seq(L[k], k = 1 .. nops(L)))), decimal, binary);
assign(d = cat("", c[1 .. 8 - length(b)], b)), `if` (type(bits, procedure),
  RETURN(R(bits([seq(SN(d[k], k=1..8)]))), `if` (type(bits, list(posint)), [seq(SN(d[k], k=bits)],
  `if` (type(bits, list(equation)), [seq(assign('d' = cat(d[1 .. lhs(bits[k]) - 1], rhs(bits[k]),
  d[lhs(bits[k])+1..-1])), k = 1..nops(bits)), RETURN(convert(SN(d), decimal, binary)),NULL)))
end proc

Bit1:= proc(B::integer, bits::{procedure, list})
local b, d, c, k;
option remember;
  assign(c = (a -> convert(a, decimal, binary)), b = NDLN(convert(B, binary))),
  assign(d = [0 $ (k = 1 .. 8 - nops(b)), op(b)]); `if` (type(bits, procedure),
  RETURN(c(NDLN(bits(d)))), `if` (type(bits, list(posint)), [seq(d[k], k = bits)],
  `if` (type(bits, list(equation)), [seq(assign('d' = [op(d[1 .. lhs(bits[k]) - 1], rhs(bits[k]),
  op(d[lhs(bits[k]) + 1 .. -1])), k = 1 .. nops(bits)), RETURN(convert(NDLN(d), decimal,
  binary)), NULL)))
end proc

xbyte:= proc(L::{list(binary)})
option remember;
  `if` (nops(L) <> 8, ERROR(`argument %1 is invalid`, L),
  convert([convert(SN(cat("", op(L))), decimal, binary)], bytes))
end proc

xbyte1:= proc(L::{nonnegint, list(binary)})
local k;
option remember;
  `if` (type(L, list), xbyte([0 $ (k = 1 .. 8 - nops(L)), op(L)], `if` (xNB(L) and length(L) <= 8,
  RETURN(xbyte([0 $ (k = 1 .. 8 - length(L)), op(map(SN, convert(cat("", L), list)))])),
  ERROR(`argument <%1> is invalid`, L)))
end proc

xNB:= N::nonnegint -> belong({op(map(SN, convert(cat("", N), list))), {0, 1})

```

Typical examples of the procedures use:

```

> Bit(`S`, [k$k=1..8]), Bit([61], [1,3,8]), Bit([61], [2=1,4=0,8=0]), Bit("G", [6]), Bit("0", [6=1,7=1,8=1]);
      [0, 1, 0, 1, 0, 0, 1, 1], [0, 1, 1], 108, [1], 7
> R:=(L::list)->[L[nops(L)-k]$k=0..nops(L)-1]: Bit("G",[k$k=1..8]),Bit("G",R),Bit("S",R),Bit([61], R);
      [0, 1, 0, 0, 0, 1, 1, 1], 226, 202, 188

```

In particular, the given example illustrates use as the second actual *bits* argument of the *R*-procedure providing the inversion of lists:

```
> K:=(L)->[L[8],L[2],L[6],L[4]+1 mod 2,L[5]+1 mod 2,L[3],L[7],L[1]]: map(Bit1, [61,56,36,40,7,14], K);
      [164, 4, 60, 20, 186, 50]
> map(xbyte, [[1,1,0,1,0,1,0,1], [0,0,1,0,0,1,0,1]]);
      ["X", "%"]
> B:=Bit("G", [k$k=1..8]); "G"=xbyte(Bit(G,[k$k=1..8])), Bit(xbyte(B), [k$k=1..8])=B;
      B := [0, 1, 0, 0, 0, 1, 1, 1]
      "G" = "G" [0, 1, 0, 0, 0, 1, 1, 1] = [0, 1, 0, 0, 0, 1, 1, 1]
> map(xbyte1, [101101, 1110101, 11101011, 11011, 1011001, 1001010, 10001001, 10000001, 10101]);
      ["-", "u", "π", "\e", "Y", "J", "%", "Í", "□"]
> map(xbyte1, [1010101,11010101,11100011,110110,10001001,10000001,1010101,11111001]);
      ["U", "X", "r", "6", "%", "Í", "U", "π"]
> map(xNB, [10011,11001101,1102011,10101,1001010011101,11100011,110110,10001001]);
      [true, true, false, true, true, true, true, true]
```

xpack – a packing/unpacking of the positive integers

Call format of the procedure:

xpack(N)

Formal arguments of the procedure:

N – a positive integer or string

Description of the procedure:

The **xpack(N)** procedure, working according to the principle of *switch*, provides a packing of positive integers (*with providing of the subsequent restoration*) by means of putting of two decimal numerals in one byte. On a positive integer as the actual **N** argument, the procedure returns the string equivalent of the number **N**, while on the equivalent the number represented by it is being returned. However, the given operation is not reversible, i.e. not each string is an equivalent of some positive integer, as that illustrates the last example of use of the **xpack** procedure of a fragment represented below. Namely, the following relation takes place: **xpack(xpack(N)) = N**, where **N** – a positive integer; this relation, in general, is incorrect for arbitrary string **N**, excluding a case when **N** is a result of the procedure call **xpack(M)**, where **M** – a positive integer.

The **xpack(N)** procedure essentially uses the **Bit** and **xbyte** procedures considered above. The examples represented below illustrate use of this procedure for a packing/unpacking of information.

```
xpack:= proc(N::{nonnegint, string})
local a, b, c, d, k, s, p, h, q, Tab_con;
option remember;
  Tab_con := table([0 = [0, 1, 1, 0], 1 = [0, 1, 1, 1], 2 = [1, 0, 0, 0], 3 = [1, 0, 0, 1], 4 = [1, 0, 1, 0],
    5 = [1, 0, 1, 1], 6 = [1, 1, 0, 0], 7 = [1, 1, 0, 1], 8 = [1, 1, 1, 0], 9 = [1, 1, 1, 1]]),
```

```

assign(q = "", h = [p $ (p = 1 .. 8)]);
if type(N, integer) then assign67(a = cat("", `if` (type(length(N), even), N, cat(`0`, N))), s = "");
  for k by 2 to length(a) do assign67('b' = SN(a[k .. k + 1])), assign67('c' = trunc(1/10*b));
    assign67('b' = b - 10*c), assign67('d' = [op(Tab_con[c]), op(Tab_con[b])]);
    assign67('s' = cat(s, xbyte(d)))
  end do;
  RETURN(s)
else
  for k to length(N) do assign67('a' = Bit(N[k], h));
    assign('b' = RTab(Tab_con, a[1 .. 4]), 'c' = RTab(Tab_con, a[5 .. 8]));
    assign67('q' = cat(q, b, c))
  end do;
  RETURN(SN(q))
end if
end proc

```

Typical examples of the procedure use:

```

> assign('G' = map(xpack, [0,1942,2004,14062004])), assign('S' = map(xpack, G)), G, S;
      ["f", "□", "tj", "zl†j"], [0, 1942, 2004, 14062004]
> xpack(424706762089961), xpack(xpack(424706762089961));
      "jЉЪЦНИняЗ", 424706762089961
> xpack(xpack("Grodno")), xpack(05240001400453510549041414), xpack(xpack("Tallinn"));
      "gvцno", "кЉЪfg†j№ k†jzz", "llinn"
> xpack(%[2]), xpack("RANS_IAN"), xpack(8938), xpack(1302198904081996), xpack("yh□пjn□Ъ");
      524000141004535105490414140, 8938, "пћ", "yh□пjn□Ъ", 1302198904081996

```

The five procedures **Bit**, **Bit1**, **xbyte**, **xbyte1** and **xNB**, represented above, along with the introduced data types *{digit, binary, byte}* create a quite satisfactory basis for operation with the symbolical information at the bit-by-bit level. In many problems, dealing with the bit-by-bit processing, these tools have shown oneself from the best party. Taking into account the important role of the *bit-by-bit* information processing in the *Maple* environment, it is supposed, the tools represented in the present chapter, should be essentially extended with increase of their reactivity and functionality. It is especially topical, for with growth of numbers of the *Maple's* releases their responsiveness is being reduced as a whole. At present, such work is being carried out, and its results (*along with others*) will be represented in subsequent updates of the *Library* attached to the book that will be available as free downloading from this web site for the book's readers.

Summary

This book introduces students and professionals into the different aspects of the famous mathematical package *Maple* of releases 6 - 9/9.5. The book is immediate continuation of our previous books on the *Maple*-problematics published in Russia, Byelorussia, Estonia and Lithuania. The basic attention is given to additional features created in the process of exploring and approbation of the package, which in many cases essentially dilate potentialities of the package. On examples of embodying of the given facilities, the application of various useful receptions, including non-standard ones, is illustrated; these receptions allow in many cases essentially to simplify programming problems in environment of the package and to make them by more transparent from the mathematical point of view. The given features cover such components of the package as the basic software environment, graphic facilities, data processing, work with the user libraries, statistical facilities and access facilities to datafiles, etc.

The given software, carried out on an *innovation* level, has organized as the user *Library*, logical linking of which with the main *Maple* library allows to use the given features at a level of the built-in *Maple* facilities. The *Library* contains well-designed software (a set of more than 570 procedures and program modules), which supplements well the already available *Maple* software with the orientation towards the widest circle of the *Maple* users, greatly enhancing its usability and effectiveness. The experience of use of the given *Library* by both the single users and in a number of universities and scientific research institutes in Russia, Byelorussia, Latvia, Lithuania, the Ukraine, Germany, etc. has shown its good operating performances at the solution of manifold interesting mathematical problems. In many cases the represented additional procedures, functions and the program modules illustrate both useful receptions of programming, and elements of the principles and methodology of programming in environment of the package.

The *Library* is intended for *Maple* of releases 6 - 9/9.5 functioning on platforms *Windows* 95/98/98SE/ME/NT/XP/2000/2003, however the *txt*-datafile attached to the *Library* allows easily enough to adapt it for the operational platforms different from *Windows*. Furthermore, the sets of source codes of all *Library* tools and help-pages composing its Help database allow easily to update the *Library* or create on its basis own libraries. The attached datafile "ProcLib_6_7_8_9.mws" contains self-installing *Library* and is oriented on execution in the *Maple* environment of releases 6 - 9/9.5. It allows to automate installation of the *Library* for the above *Maple* releases.

Each software represented in the book is supplied with description and explanations, and contains the source code and the more typical examples of its application. As required, the description has supplied by the necessary considerations, concerning peculiarities of its execution in the *Maple* environment of one or another release, and of the current *Windows* platform.

Alongside with it, presence of source codes of procedures and program modules containing a whole series of both effective and non-standard receptions of programming, allows to use them in programming various applied tasks. In particular, rather effective method called by us as "*disk transits*" can be used for programming dynamically generated program constructions. This method is rather useful in conditions of advanced programming in *Maple*. The given method has been developed by us and successfully used for computers of 3rd generation (IBM/360, IBM/370, etc.) and appeared especially effective with appearance of the personal computers whose development is characterized (*including*) by enough quick decreasing of time of access to external

memory on hard disks. Rather interesting receptions of creation of high-performance one-line extra-codes are represented by source codes of procedures.

Procedures and program modules of the given list have various complexity of organization and used algorithms; in many cases, they use both effective and non-standard receptions of programming in the *Maple* environment. At the same time, in a whole series of cases they allow to simplify essentially programming of various tasks in *Maple* and have well shown oneself in many applications of the package of releases 6 - 9/9.5. The given means can be used as individually (*for the decision of various problems or for creation on their basis of new means*), and in structure of the user library extending standard means of the package, eliminating a number of defects and mistakes of the package, raising compatibility of the package relatively to its releases and raising efficiency of programming of problems in its environment. From our six-year experience of the package usage in various applications and from experience of our colleagues from universities and the academic institutes of the Baltic States, Belarus, Russia, Czechia, Poland, Germany, the USA, etc. a lot of the procedures represented here or their clones are rather expedient for including in set of standard means of the package of the subsequent releases.

The tools represented in the *Library* increase the range and efficiency of use of the package on the *Windows* platform owing to the innovations in three basic directions: (1) elimination of a series of basic defects and shortcomings, (2) extension of capabilities of a series of standard tools, and (3) replenishment of the package by new means which increase the capabilities of its program environment, including the features essentially improving the compatibility of releases 6 - 9/9.5. The basic attention has been devoted to additional tools created in the process of practical use and testing of the package of releases 4 - 9 that by some parameters considerably extend the capabilities of the package making the work with it much easier; a considerable attention is also devoted to the tools providing package compatibility of releases 6 - 9/9.5. The experience in using the above software for various applications has confirmed its valuable operational characteristics.

It should be noted that a series of our books and papers on *Maple*, representing tools developed by us and containing suggestions on further development of the package encouraged the development of such applications as package modules **FileTools**, **LibraryTools**, **ListTools** and **StringTools**. All this allows to hope, that the represented book and the software attached to it will appear useful enough to broad audience of the *Maple* users, both for the beginners and the skilled ones.

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List of procedures and program modules represented in the monograph

&Shift, _0N, _1N, _nnn, _mMfile, _rd, _SL, A_Color, ACC:- acc, ACC:- Ds, ACC:- Sr, Aconv, ACP, Adrive, AFdes, AlgLists:- &*, AlgLists:- &+, AlgLists:- &-, AlgLists:- &/, AlgLists:- &^, All_Close, AnalT, Animate2D, Animate3D, andN, Aobj, Apmv, Aproc, Arojb, ArtMod, Assign, assign6, assign67, assign7, AtrRW, avm_VM, belong, Bit, Bit1, blank, Built-in, came, Case, Catch_Vir, CCF, CCM, CDiag, CDM, CF, CF1, CF2, cfdd, CFF, cfln, Chess, ChkPnt, Close, Clr, Cls, cdt, clsd, cmlib, cmtf, cnvtSL, CoefTaylor, com6_9, CompStr, Con_Mws, conSA, conSV, ContLib, convert/list, convert/listlist, convert/lowercase, convert/module, convert/rlb, convert/set, convert/ssl, convert/TEXT, convert/uppercase, conwf, Cookies, CorMod, CorMod1, CrNumMatrix, CS, CureLib, Currentdir, D_ren, DAclose, DagTag, DAopen, DAread, dcemod, DDT, DeCod, decode, DeCoder, DefOpt, DEL_F, delf, delf1, delsc, deltab, DestLm, Dialog, diffP, Dir, Dir_ren, dslib, DIRAX:- conv, DIRAX:- delete, DIRAX:- empty, DIRAX:- extract, DIRAX:- insert, DIRAX:- new, DIRAX:- printd, DIRAX:- replace, DIRAX:- reverse, DIRAX:- size, DIRAX:- sortd, DirE, DirF, DirFT, Dist_rand_n_2, DoF, DoF1, DT, DUlib, E_mail, email, Empty, EntS, Etest, etf, Evalf, ewsc, exeP, expLS, Extract, ExtrF, extrS, F_alias, F_Analys, F_atr, F_atr1, F_atr2, F_ren, F_T, F_test_Ds, F_Type, Fac, Fappend, FBBcopy, FBcopy, FBfile, FD, Fend, Fequal, FFP, filePM, FindFSK, FLib, FLib1, FLL, FmF, FNS, Fnull, FO_state, FOR_DO, Fopen, fpathdf, Fremove, frss, FSSF, FT_part, FT_part1, FT_restr, FT_subs, FTabLine, FTabLine1, FTcopy, FTmerge, ftpd, Ftype, Fword, gelist, Gener, GenFT, getable, GG, Heap, helpman, Histo, holdof, howAct, HS_1D, IAN_REA, Iddn, Iddn1, IdR, IDS, Images, Imaple, Indets, inel, Ins, Insert, insL, InstUlib, INT, InvL, InvList, InvT, IO_proc, IP, Is_Color, isDir, IsFempty, isFile, isflo, IsFtype, isLnkMws, ismLib, isMSDcom, IsOpen, IsOpen1, IsOpen2, IsOpenF, IsPtf, isRead, KCM, KL, KL1, Kr_Mesh, LGD, LibElem, LibElem1, LibElem2, LibLink, LibLink1, LibUser, Linear_Const, LnFile, LO, LocalnL, Lrare, LRM_NRM, LSF, LSL, LT, LTfile, M_Type, MA, MAM, map3, map4, map5, MapleLib, mapLS, mapN, mapTab, MatrSort, maxl, MEM, Mem, Mem1, memberL, MiniMax, minl, MinMax, MkDir, MmF, mmf, mmp, mod21, mod3, mod_proc, ModFile, ModProc, modproc, mpl_proc, MPL_txt, mPM, MSDcom, mtf, Mulel, mws789_6, Mwsin, MwsRtb, N_Cont, NDln, NDP, NDT, Nint, nlcvector, nLine, NLP, NonaLP, Nstring, null, NumOfString, OP, open2, OpenLN, Open, orN, ParProc, ParProc1, Path, pathtf, perml, permlib, Pind, Plib, plotTab, Pnd, PNorm, Polyhedra, porf, Porshen, Pos, PP, PSubs, Pul_Bal, Pul_Bal_Cor, Pulsar, Q2plot, Qfline, Qsubstr, Queue, rand_Histo, Read, Read1, read3, readdata1, ReadProc, reconf, Red_n, redL, RedList, redlt, redss, Reduce_T, RegMW, Release, Release1, relml, Remember_T, reprolib, Residue, Resl, ResRtb, Rev, Rfact, rID, Rlss, Rmdir, rmdir1, Rmf, rName, Root, RS, RSLU, Rssl, Rt_s, RTab, Rtable, RTfile, RTsave, S_D, SA_text, Save, save1, Save1, save2, Save2, save3, SaveMP, SaveProc, SD, SD_S, SD_S1, SDF, Search, Search1, Search2, Search3, Search_D, Search_D1, Search_D2, SEQ, seq1, seq2, seqstr, sext, sext, sext1, sident, SimpleStat:- ACC, SimpleStat:- CC, SimpleStat:- CR, SimpleStat:- Ds, SimpleStat:- FD, SimpleStat:- LRM_NRM, SimpleStat:- LT, SimpleStat:- MAM, SimpleStat:- MCC, SimpleStat:- PCC, SimpleStat:- Sko, SimpleStat:- SR, SimpleStat:- Weights, SL, SLD, SLj, SLS, sls, Sls, Smart, Smart_Plot, sMf, SN, SN_6, SN_7, SN_8, SN_9, sof, SoLists:- intersect, SoLists:- minus, SoLists:- sublist, SoLists:- union, SortL, sorttf, Sproc, SQHD, SS, SSet, SSF, ssf, SSN, sspos, sstr, STACK, statf, StatLib, stpm, Sts, stype, sub_1, Sub_all, Sub_list, SUB_S, Sub_st, Subs_All, Subs_all1, Subs_all2, subseqn, Subset, subSL, subsLS, Suffix, swmpat, swmpat1, Sys_Env, T_Font, T_SQHD, T_SQHT, T_test_AV, tabar, TabList, Test, transmf7_6, trConv, TRm, ttable,

type/binary, type/boolproc, type/byte, type/digit, type/dir, type/dirax, type/file, type/heap, type/letter, type/Lower, type/lower, type/mlib, type/mod1, type/nestlist, type/package, type/fpath, type/path, type/realnum, type/rlb, type/sequent, type/setset, type/ssign, type/Table, type/Upper, type/upper, Type_D, typeseq, U_test_MW, UbF, Ulib, ulibpack, Uninstall, UpLib, User_pfl, User_pflM, User_pflMH, UserC, Users, V_Solve, VisM, Vol, Vol_Free_Space, VTest, Weight_LF, Weights, Weights_L, winver, writedata1, WD, WDS, WS, WT, X_test_VW, xbyte, xbyte1, xNB, xorN, xpack, XSN, XTfile, intaddr, minmax3d, plotvl, type/complex1, varsort, MSK, ExprOfString, com_exe1, com_exe2, mwsname, Kernels, frame_n.

Procedures and program modules of the given list have various complexity of organization and used algorithms; in many cases, they use both effective and non-standard receptions of programming in the *Maple* environment. At the same time, in a whole series of cases they allow to simplify essentially programming of various tasks in *Maple* and have well shown oneself in many applications of the package of releases 6 - 9. The given means can be used as individually (*for the decision of various problems or for creation on their basis of new means*), and in structure of the user library extending standard means of the package, eliminating a number of defects and mistakes of the package, raising compatibility of the package relatively to its releases and raising efficiency of programming of problems in its environment. From our six-year experience of the package usage in various applications and from experience of our colleagues from universities and the academic institutes of the Baltic States, Belarus, Russia, Czechia, Poland, Germany, the USA, etc. a lot of the procedures represented here or their clones are rather expedient for including in set of standard means of the package of the subsequent releases.

The above-named 578 *procedures* and *program modules* have been organized into the user Library provided with Help database that are structurally analogous to the main *Maple* library. After logical linking of it with the main library, the tools contained in it can be used analogously to standard *Maple* tools.

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Aladjev V. was born on June 14, 1942 in the town of Grodno (*Western Byelorussia*). After successful completion of the secondary school in 1959, he matriculated on the first course of physical and mathematical faculty of Grodno State University and in 1962 has been transferred to the Department of Mathematics of Tartu State University (*Estonia*). In 1966, he successfully finished Tartu State University the speciality of *Mathematician*. In 1969, **Aladjev V.** started post-graduate studies of the Estonian Academy of Science, and successfully finished in 1972 two specialities "*Theoretical Cybernetics*" and "*Technical Cybernetics*". The doctoral degree in mathematics has been assigned to him for the monograph "*Mathematical Theory of Homogeneous Structures and their Applications*". From 1972 to 1990, **Aladjev V.** has the respectable positions in a number of project-technological and research organizations of Tallinn (*Estonia*). In 1999, he has been appointed the president of the *Tallinn Research Group* (TRG), the scientific findings of which received international recognition, first, in the field of activities in mathematical theory of Homogeneous Structures (*Cellular Automata*). **Aladjev V.** is the author of more than 300 scientific and technological publications, including 60 monographies, books and collections of the articles, published in the former USSR, Estonia, Great Britain, Russia, Byelorussia, GDR, the Ukraine, Lithuania, Germany, Hungary, USA, Czechoslovakia, Japan and Holland. He founded the Estonian school of mathematical theory of Homogeneous Structures that has been recognized internationally and covered the fundamentals of a new section of modern mathematical cybernetics. **Aladjev V.** participates as a member of the organizing committee and/or a guest lecturer in many international scientific forums in mathematics and cybernetics. In April 1994, **Aladjev V.** has been elected as an *academician* of the Russian Academy of Cosmonautics in the section of "*Fundamental Researches*", and in September 1994, he has been elected as an *academician* of the Russian Academy of Noosphere in the section of "*Information Science*". In September 1995, he has been elected as an *academician* of the Russian Academy of Natural Sciences in the section of "*Noosphere Knowledge and Technologies*", and in June 1998 as an *honorary academician* of the Russian Ecological Academy. In November 1997 **Aladjev V.** has been elected as the *academician-secretary* of the Baltic Branch of the Russian Academy of Noosphere, integrating scientists and specialists of three Baltic countries and Byelorussia, who work in the field of a complex of scientific disciplines, which are included in the doctrine about *Noosphere* and areas, adjacent to it. Because of reorganization of the Russian Academy of Noosphere into the International Academy, **Aladjev V.** has been elected as its First vice-president in December 1998. At last, in December 1999 **Aladjev V.** has been elected as a *foreign member* of the Russian Academy of Natural Sciences in the section of "*Information Science and Cybernetics*". At present, **Aladjev V. Z.** is *academician-secretary* of the Baltic Branch of the International Academy of Noosphere. Most considerable scientific results of **Aladjev V.** are related to the mathematical theory of homogeneous structures and its applications. The sphere of his scientific interests includes mathematics, informatics, cybernetics, computer science, physics, cosmology, etc.