UDC 510.6

STRUCTURE AND POSSIBILITIES OF PM «SOLVING ENVIRONMENT» OF INTEGRATED PROGRAMMATIC ENVIRONMENT «MATHLOGIC V.2»

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This article presents the PM 'Solving environment' of integrated programmatic environment Mathlogic v.2, (ML2) which was made within the framework of project of Terra Mathematica in the Laboratory of Pedagogical Software Development and Implementation. The article describes the structure of PM «Solving environment», exposes features of its functionality, and also technologies and methods which were used for their realization.

Keywords: mathematical logic, utterance (proposition), predicate, logic of utterances (or logic of propositions), quantifier.

Glossary

- Mathematical logic is a section of mathematics, studying proofs and questions of grounds of mathematics. In obedience to determination of P.P.Poreckij, «mathematical logic is logic on an object, mathematics on a method». In obedience to determination of N.A.Kondakov, «mathematical logic – second, after traditional logic, stage in development of formal logic, applying mathematical methods and special vehicle of characters and probing thought by calculations (formalized languages).» This determination corresponds determination P.K.Kleene: mathematical logic is «logic, developed by mathematical methods». Similarly A.A.Markov determines modern logic «exact science, applying mathematical methods». All these determinations do not contradict, but complement each other.

- An utterance (proposition) is a base concept of mathematical logic and formal logic. An utterance is name affirmative narrative suggestion which formalizes some expression of an idea. An utterance has an only one boolean value usually.

- A predicate (n-local) is a function with the area of values {0, 1} (or «Lie» and «Truth»), certain on n of Cartesian degree of great number of M. Thus, each n elements of M it characterizes either as «true» or as «false».

- A quantifier (from lat. quantum – how many) is the general name for boolean operations, limiting the area of truth of some predicate. More frequent than all mention the quantifier of generality (denotation: read: «for all.», «for any.» or «any.») and quantifier of existence (denotation: read: «exists.» or will «be.»). In mathematical logic attribution of quantifier to the formula is named fastening of quantifier.

- Logic of utterances (or logic of propositions) is a formal theory the basic object of which the concept of logical utterance serves as. Logic of utterances is the simplest logic, maximally near to human logic of the informal reasoning and known yet from times of antiquity.

- Logic of the first order (calculation of predicates) is a formal calculation, assuming utterances relatively variable, fixed functions, and predicates. Extends logic of utterances. In same queue is the special case of logic of higher order.

Raising of problem.

Improvement of efficiency of study of course of mathematical logic by the students of universities, that it can be attained by the use of the dedicaded programmatic system of the educational setting, which supports rozvyazannya of typical tasks of mathematical logic.

Architecture of project

In development of environment of Mathlogic v.2 was used architectural and technological decisions constructions of the mathematical systems of the educational setting, developed before in

a project Terra Mathematics. Technologies of character transformations and methods of computer algebra are thus used.

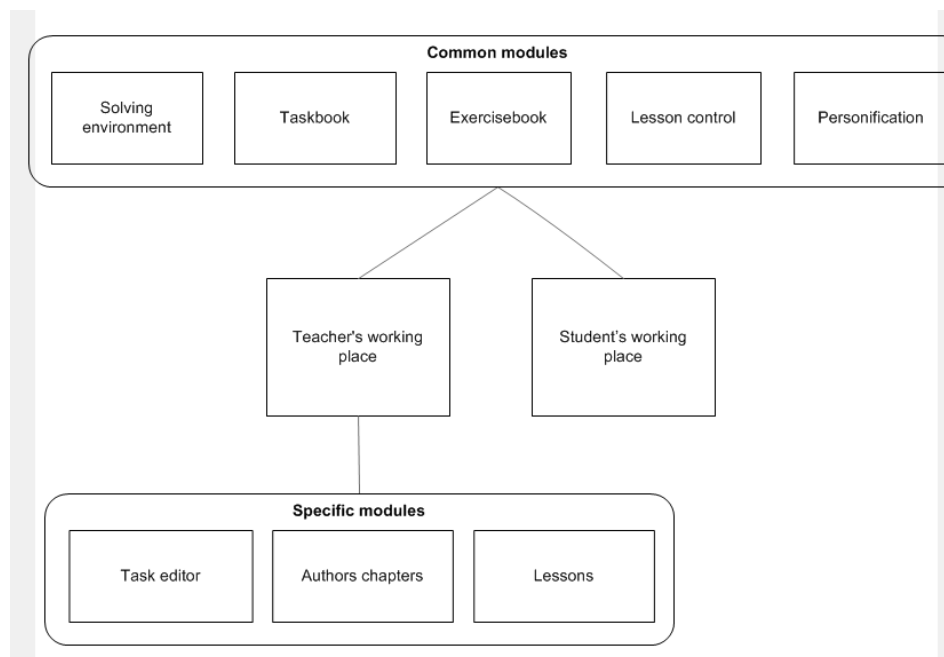ML2 is intended for support of course of logic and calculation of utterances and predicates.

Fig. 1. Architecture of project

Structure and possibilities of PM «Solving environment»

PM „Solving environment" is intended for the solving of tasks and demonstration of motion of their solving. Tasks, solved by teacher, will be saved in the library of tasks. They can be included in the complement of task book. Students can use PM « Solving environment » too.
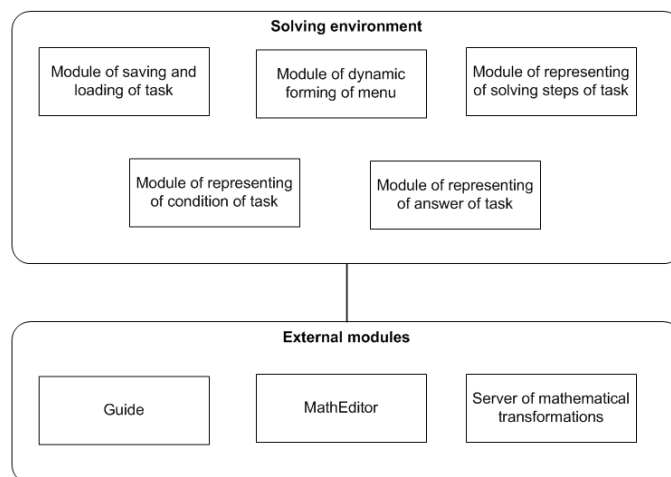

Fig. 2. The structure of PM «Solving environment » and it's co-operating with other modules
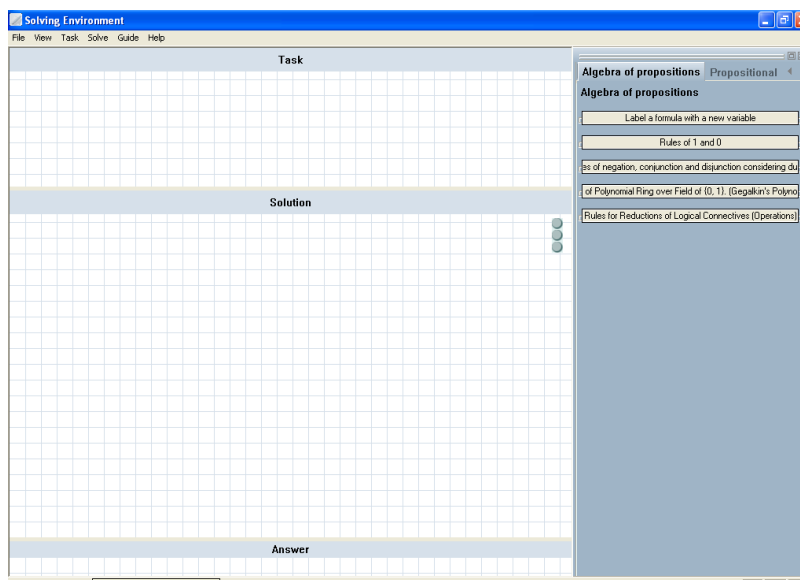
Fig. 3. The window of "Solving environment"

In main part of window user solves the task. Field Task contains the condition of the task. Field Solution of task contains the motion of solving of the task. Motion of solving of the task consists of sequence of steps. The step of solving is executed by user with facilities of Guide. Field Answer contains the answer of the task. If user has specified an answer, the solving is completed.

The purpose of the teacher is demonstration of methods of solving of task during explanation of new material. For this purpose teacher has to:

1) To open PM «Solving environment».
2) To enter a necessary condition in the special window.
3) To solve a task
4) To save motion of solving in the library of tasks.
5) To add to the lesson this task from the library of tasks.
6) To save this lesson in a library.

Below we will consider the structure of main menu of PM «Environment Solving environment ». Its basic elements are menus: File, View, Task, Solve, Guide and Help.

«File» menu:

1) Command «To Save a task».

This command opens the window of saving of task. To save motion of solving of tasks in the Exercise book, it is necessary to select with a mouse the proper section of library and to push the button YES or to create a new section. After that it will be necessary to enter the number of task in the proper window and to push the button YES.
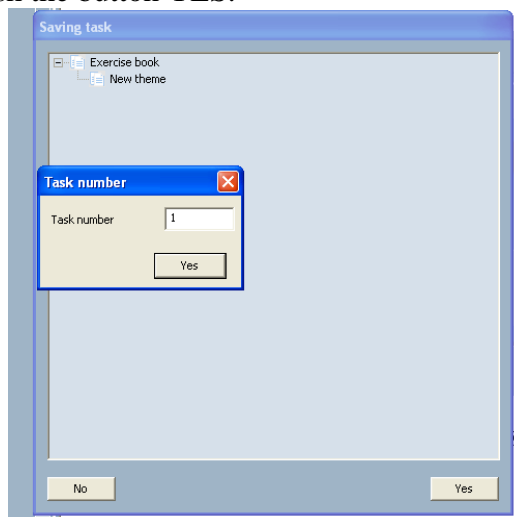

Fig. 4. Saving task window

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1) Command «Print version».

By this command it is possible to look over a version for the printing of the chosen document.

«View» menu:

1) A command «Guide» opens the window of PM «Guide».
2) A command «Extended guide».
3) At the choice of this command in Guide will be represented not only text but also formula information about transformations.
4) Command «Auto scroll».
5) Every new step causes the automatic vertical scrolling of the field, which moves solving steps upwards, here the overhead step hides for the high bound of the field.
6) Command «Step by step scroll».

Command sets the mode at which vertical scrolling of motion of solving of task in the field Decision of task is carried out on the steps of decision.

Menu «Task» – a command «New task» opens submenu, with facilities of which user chooses one of standard types of tasks the conditions of which can be entered from a keyboard.
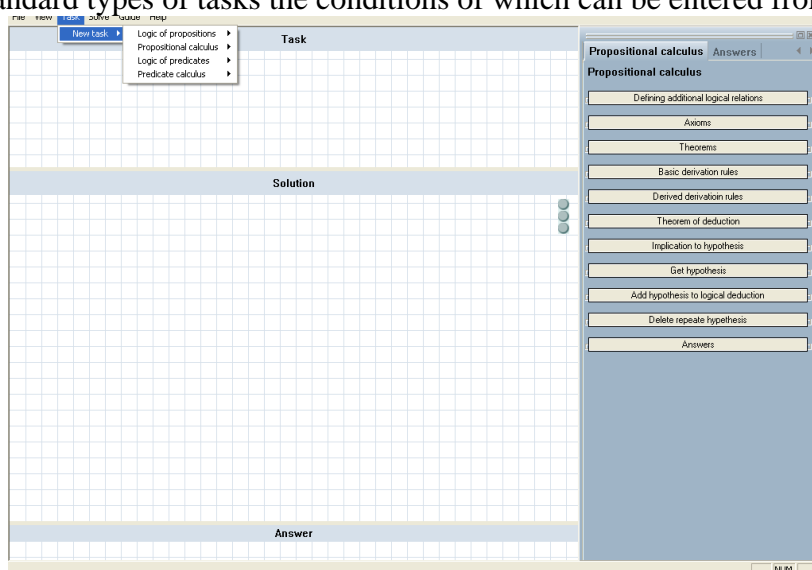

Fig. 5. Menu "Task"

The choice of the one of possible types of tasks will open the New task window, facilities of which a user enters a condition. Text part of task is entered in the field of text of condition. A formula from which a solving begins with is entered in the field of formula of the task with facilities of mathematical editor. To complete the input of condition – push the Apply button.
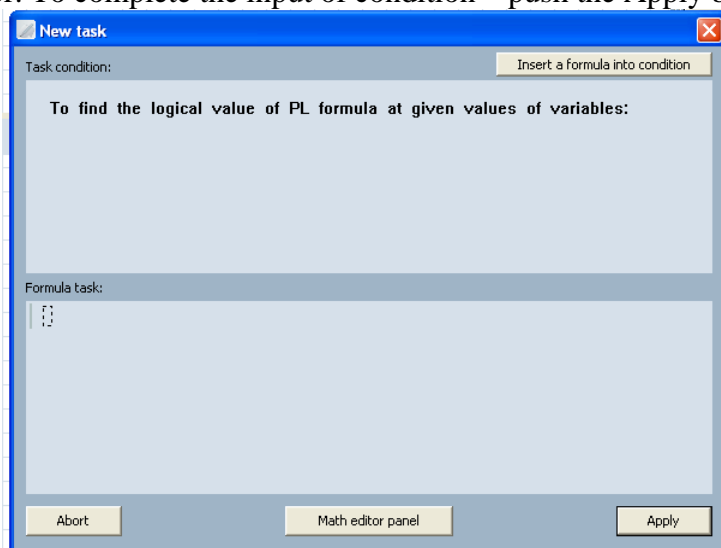

Fig. 6. New task window

Menu «Solve» the «Begin» command.

After the input of condition it will be represented in the field Task condition. To begin the solving it is necessary to execute a «Begin» command. In the field Solution of task will appear the first step of solving.

Menu «Help» contains the commands for opening the files which are intended for a help to user.

The Solving environment supports the mode of rightness verification of the step of solving. Thus the user marks in a logical formula a subformula, which he wants to transform and chooses in Guide that transformation which it is necessary to execute. An Environment executes this transformation (if it is applicable). Thus, an environment shuts out errors, giving the user to choose motion of solving of task.

A chart, describing co-operation of the programmatic modules between itself at implementation of transformations to PM «Solving environment», and also at verification of the executed step, is resulted below:
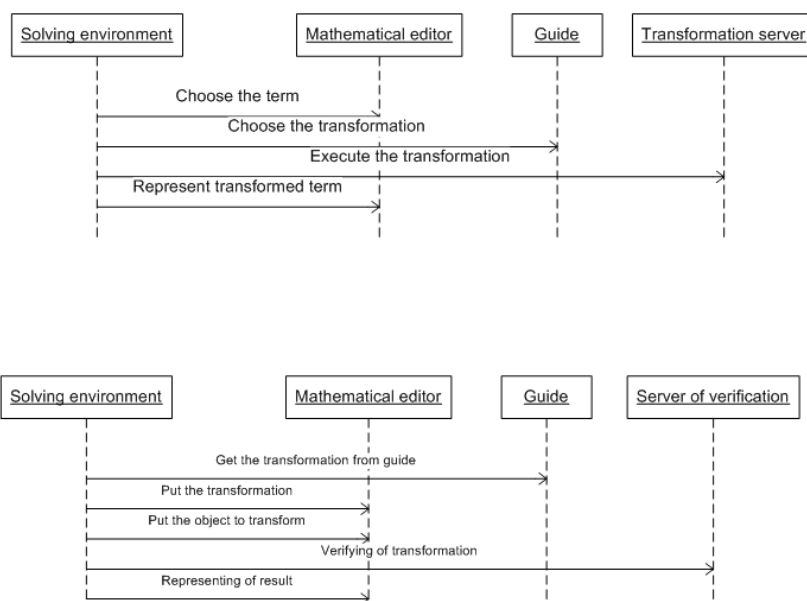

Fig. 7. Co-operation of the programmatic modules

Structure of PM "Guide"

Possible transformations for a solving are presented in the structured kind in Guide. The complete list of transformations is resulted below.

Algebra of propositions:

1) Replacement, substitution, values of boolean expressions (Rule of replacement, Rule of Changing of Subexpression by Equivalent one, Rule of calculation of value, Rule of calculation of truth table, Rules of calculation of SDNF (SKNF) on by truth table).

2) Rules of 0 and 1 (for conjunction, disjunction, negation, implication, equivalence, Shaffer and Piers strokes).

3) Laws of algebra of propositions (1st law of reduction, De Morgan's laws, laws of idempotency).

4) Rules for Reductions of Logical Connectives (for conjunction, disjunction, negation, implication, equivalence, addition mod 2, Shaffer and Piers strokes).

5) Laws of Polynomial Ring over Field of $\{0, 1\}$. (Gegalkin's Polynomials) (associative law for multiplication, associative law for addition mod 2, commutative law addition mod 2, commutative law for multiplication, distributive law for multiplication and addition, idempotency law, neutral and null elements laws for multiplication and addition).

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Propositional calculus:
1) Determination of additional logical operations
2) Axioms
3) Theorems
4) Main rules of inference
5) Derivative rules of inference
6) Theorem of deduction

Algebra of predicates:

Rules of: replacement of an apparent variable; commutativity of quantifiers of generality and existence; quantifier of generality and conjunction; quantifier of existence and disjunction; rules of de Morgan.

Predicate calculus:

1-3. Axioms of CP

4. $\forall x A(x) \rightarrow A(t)$

5. $\forall x(A \rightarrow B) \rightarrow (A \rightarrow \forall x B)$

6. Rules of inference: Modus ponens and rule of generalization.

Solving environment can be adjusted in accordance with the wish of user. Tuning consists in the choice of signature and denotations of logical operations, and also in the choice of the logical system.

Conclusions.

This programm environment allows to decide assigned problem in complete volume. It is opened for a subsequent revision and perfection, exposes prospects on the future.

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