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DEVELOPMENT OF AUTOMATED SYSTEM FOR MASTER'S DEGREE PROGRAM TIMETABLE GENERATION

There had been developed the model for automated system for Masrers degree program timetable generation. The system realizes methods for generating timetable for Master students curriculum with scientific direction in VNTU. The methodic considers specific charter of personal plans of Master students, adapted to the requirements of Bolonga process. This development is a structural model of automated system for documents turnover in the Institute for Master, Post-graduate and Doctor Degree study.

Key words: *automated system for timetable generation, timetable, mathematical models of timetable, system for documents turnover, personal plans of Master students.*

Introduction

Number of modern software in the sphere of education is presented by different means of documents turnover and training process management. The known [1, 2] program for timetable generation "Reactor" ensures for automated semi-automated and manual mode of operation; realizes the process of joining classes, divides students streams in groups, encounts for sanitary and epidemic rules and norms of educational establishment. Set of functions in program ASC TimeTables is wider and includes additional options for controlling over psychological and pedagogical for teachers and students [3, 4].

Program "TimeTable PRO" [2,5] is designed for both manual timetable generation using "drag-and-drop" method, and automated made ensuring exporting to Microsoft Excel table. This program This program has the realized function for separating information for students and teachers. The program "University" [6] generators timetable stipulating for classes to be held in different University buildings, it has multilanguage interface and multiformat export. The above programms, however, do not consider modern approaches to the organization of training system in institutions for higher educational and principles of Bolanga process.

Urgency of this development lies in the becessity of improvement of timetable generation process aimed at improving the efficincy in documents turnover in Institute for Master, Post Graduate and Doctor Degree Study [In MPGDDS] due to using the automated modes for formation of timetable for Master students in Vinytsia National Technical University (VNTU), considering modern requirements of institutions for higher education to organization of training process. The objective of thhis work is to automate the process of timetable generation by development of local module for automated system of documents turnover in In MPGDDS. The object of the research is the process for automated timetable generation with its further optimization.The subject of the system are means for creation of automatized system for documents turnover in institution for higher education. The main tasks of the work are: development of software for generating timetable of subject for Masters training in In MPGDDS, creation of data base for starting necessary information, development of methods for realization of automatized processess.

Task setting

Institute for Master, Post Graduate and Doctor Degree Study in VNTU realizes the development of automated system for formation of documents turnover in the Institute, ensuring local and net mode for users. One of the important function of the system is the task of automated timetable generation for Master Students with scientific direction. The initial conditions require creation of module of the automated system "Timetable generation" and accompaning process. The

specificity of personal plans of Master students, which are adapted to requirements of Bolonga process in also of great significancy. Such plans accumulate blocks of compulsory subjects, blocks of voluntary subjects to be chosen by students and which form the module provision of integral subjects for specialities, blocks of subject aimed at training specialists according ot post graduate curricula. It is also necessary to pay attention the necessity of mutual coordination of specific parameters of the developed module with the total automated system for keeping documents in In MPGDDS which stipulates for the possibility of mutual usage of common data bases in the process of choosing necessary information and implementing common protection system. Realization of initial conditions for creation of automatized system stipulates for the development and using the separate module for users authorization with further software support of users and administrative mode of operation. Module for users interface support must ensure the possibility of entering and editing information, producing from the received access rights given by module of authorization, determination of searching parameters of information inquiries; viewing, storing, printing documents. Informational provision of a system in saved in MySOL data base with administrator's access only. Procedure of export (import) of data is made by search for the identified code of the plan by number of speciality, for which the modification is allowed. Our task is to develop Method for automated generation of timetable and models for automated system for its realization.

Analyses of informational provision for the system

Timetable accumulates information on subjects, academic groups, teachers and lecture golls, stipulating for creation of complex system of interconnection between information tables in process of generation. Keeping common data on teachers' and students' loading during timetable generation and choosing lecture halls, meeting number of places, requires the use of optimized methods of information processing. Labor capacity of timetable generation in institutions for higher education is also a difficulty which, in turn, stipulates for the urgency for the development the automated system for timetable generation, aimed at automation of the routine processes of the information streams and optimization of timetable structure.

Training process traditionally uses such types of classes: lecture, practical class, seminar, laboratory work and students independent work; the latter activity is not included in timetable. During timetable generation, the number of classes per week is not fixed and is determined by optimal load distribution [7-12].

The system of connection between separate database tables is also important. Recording and reading of information is realized with pattern which is unique for all tables and includes preliminary selection and copying of data into the work table "Timetable" of the module data base. This table is the main source of information provision for the process of formation of final documents, which reflect the result of inter-department distribution of loading with subject for Masters' training.

Apart from that it is also important to ensure protection against possible errors caused by operator failures. These principles are main for creation of automated system and are realized by system introduction of access possibilities arrays to the information provision of data base. Thus, selection of group stipulates for access to those subject from curriculum, which are thought to this in the current trimester.

Structural diagram of users' interface (fig.1) demonstrates provision of software environment with functional possibilities of automation process.
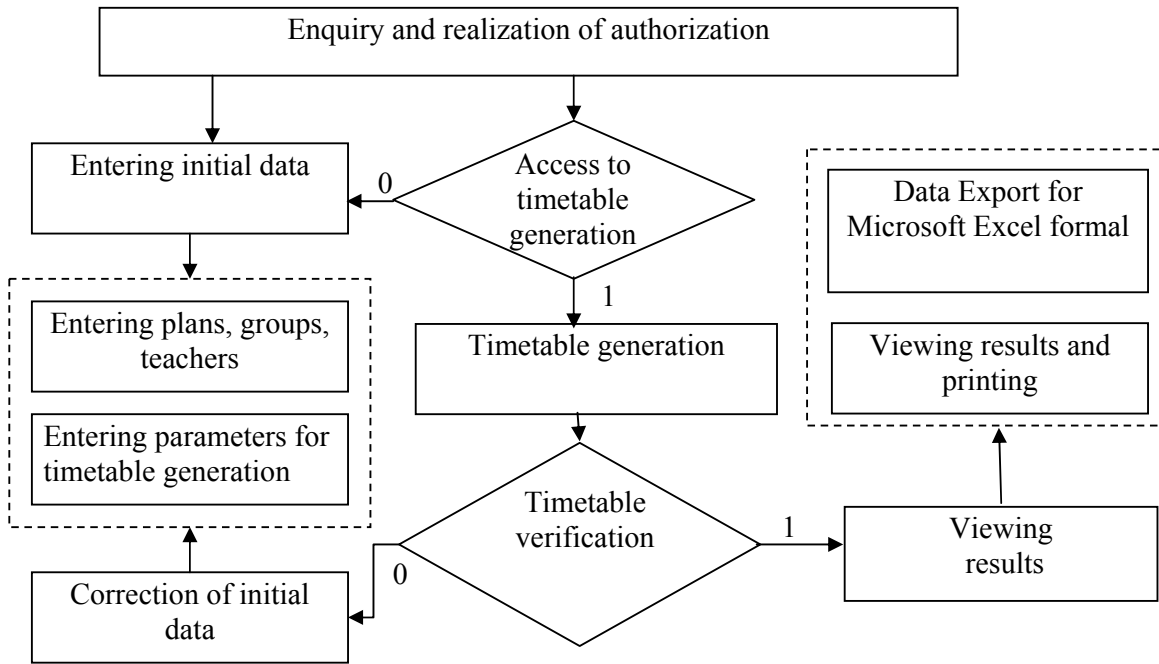
Fig. 1 Structural diagram of users interface

3. Mathematical model for generation of individual timetable

Determination of information factors of the system for timetable generation stipulates for the following sets: $T = \{T_1, T_2, \ldots, T_{m_t}\}$ – set of teachers; $M = \{M_1, M_2, \ldots, M_{m_m}\}$ – set of Master students; $D = \{D_1, D_2, \ldots, D_{m_d}\}$ – set of subjects.

Due to realization of individual selection of subjects' blocks according to requirements of Bologna process, the value of parameter m_m is determined by number of master students, which learn the selected subject in a definite discrete moment of time, is within 1 (class in subject from block of individual selection of subject) and m_m (for example, lecture on subject, which is taught to all Master students).

there are following subjects' types in timetable:

$$D_i = \{L_{i1}, L_{i2}, \ldots, L_{i7}\},$$

where L_{i1} – lecture class, L_{i2} – class in laboratory practicum; L_{i3} – practical class; L_{i4} – seminar; L_{i5} – independent students work; L_{i6} – course papers; L_{i7} – course projects.

Each class L_{ij} requires p_{ij} time and may be taught by teacher of the set $\tau_{ij} \subseteq \{T_1, \ldots, T_{m_t}\}$ (i – subject; j – type of class) to Master students from the set $\mu_{ij} \subseteq \{M_1, \ldots, M_{m_m}\}$ – who chose the 1th subject.

Thus, the priority direction in the solution of the task is the conceptual analysis of the main characteristics of the process of Master students timetable generation, such as : α – teachers characteristics; β – Master students characteristics; γ – subject's characteristic and relational formation of target functional of the task δ .

Researches [5] allow to assert that the field α consists of two parts $\alpha = \alpha_1 \cap \alpha_2$: $\alpha_1 = P$ – teachers loading with subjects of Masters training.

Total time of teachers' loading is:

$$p_k = \sum_{i=1}^{n}\sum_{j=1}^{7} q_{ij} \left|\begin{array}{l} q_{ij} = p_{ij}\left|(\tau_{ij} = T_k)\cap\left(\sum_{i=1}^{n}\sum_{l=1}^{m_m}\mu_{il} > 0\right)\right.; \\ q_{ij} = 0\left|(\tau_{ij} \neq T_k)\cup\left(\sum_{i=1}^{n}\sum_{l=1}^{m_m}\mu_{il} = 0\right)\right.. \end{array}\right.$$

The second parameter $\alpha_2 = W$ – weighting coefficient of teachers' rating.

Marking the set of classes as λ_{du}, where $TD \in \{1, 2, 3, 4, 5\}$ – working day of the week, $TU \in \{7, 8, 9, 10\}$ – number of scientific direction, we receive the set of time intervals $TR = TD\,xTU$.

Let's write examples for possible limitations for the k-th teacher:

$x_{k1} = \lambda_{du}\left|(d \in \{3, 4\})\cap(7 < u < 10)\right.$, $x_{k2} = \lambda_{du}\left|(d = 5)\cap((u = 9)\cup(u = 10))\right.$;

$x_{k3} = \lambda_{du}\left|(d \neq 1)\cap(d \neq 4)\right.$, $x_{k4} = \lambda_{du}\left|((d = 1)\cap(u = 10))\cup(d > 1,\ \forall u)\right.$.

Characteristic parameters of Master students in the generalized system for timetable generation are represented as the following contamination: $\beta = \beta_1 \cap \beta_2$, where $\beta_1 = G_i$ – Master students enter specific groups which differ in speciality of basic training and department of professional direction.

$\beta_2 = F_i$ – Master students from a number of streams according to the individual plan of master's training: $F = \{F_1, F_2, \ldots, F_{11}\}$.

Where F_1 – common stream of Master students; F_2 – streams of Master students for practical classes and seminars inhumanity, social and economic subjects ; F_3 – professional streams of Master students for teaching theoretical subjects; F_4 – joined streams of Master students for subject of scientific directions; F_5 – streams of Master students for subjects of scientific direction; F_6 – streams of Master students of separate specialities or Departments for teaching applied aspects of Master training subjects; F_7 – streams of common and separate specialities for teaching integral subjects; F_8 – streams of Master students for teaching foreign language; F_9 – streams of Master students for teaching subjects of different specializations; F_{10} – streams of subjects for teaching chosen subjects in humanity, social and economic subjects; F_{11} – stream of Master students with individual choosing subjects.

The field γ is directed to the following characteristics: $\gamma_1 = f_{ij}$ – subject belongs to the plan of speciality and is taught randomly.

Time for classes of the k-th Master student upon the individual timetable is determined by the expression

$$: r_k = \sum_{i=1}^{n}\sum_{j=1}^{7} q_{ij} \left|\begin{array}{l} q_{ij} = p_{ij}\left|(\mu_{ik} > 0)\right.; \\ q_{ij} = 0\left|(\mu_{ik} = 0)\right.. \end{array}\right.$$

$\gamma_2 = R$ – subjects belong to set of subjects, chosen by the Master student. Set of beloninng of

the subject to the personal plan of Master student. Set of belonging of the subject to the personal plan of Master student:

$$R \subseteq D \mid p_i = \sum_{k=1}^{m_m} q_{ik} > 0 \begin{vmatrix} q_{ik} = p_{ik} & \mid \mu_{ik} > 0 \\ q_{ik} = 0 & \mid \mu_{ik} = 0 \end{vmatrix} \quad \text{for } i = \overline{1, m_d}.$$

$\gamma_3 = J$ – type of class, tought by one or some teachers. Set of belongings of the subject to personal plan of teacher

$$\tau_{ijk} \in \{0, 1\}, \text{ where } i = \overline{1, m_d} \ j = \overline{1, 7} \ k = \overline{1, m_t} : J \subseteq D \mid \sum_{k=1}^{m_t} \tau_{ijk} > 0 \mid p_{ij} > 0, \forall i, \forall j.$$

Consequently, with the loading p_{ij} of any type of class for all the subjects there will be determined one or some teachers (for example, in case of teaching integral subjects) or for conducting of the ij-th class.

$\gamma_4 = B = B_1 \cup B_2 \cup B_3$ – division of subjects as for the type of the class according to __ of the week, where B_1 – set of every week class; B_2 – set of classes which take place once in two weeks; B_3 – set of classes, the number of which is not __ to the half number of weeks (such classes are planed in specific dates). $\gamma_5 = H$ – division of subjects types, considering limitations, which are stipulated for by psychological and pedagogical peculiarities of teaching and perception by Master students of scientific direction: $h_k \in \{-20, \dots, 20\}, \ k = \overline{1, m_h}$, where m_h – number of psychological and pedagogical limitations.

Target function of automated timetable generation δ considering necessary conditions with maximum number of scores:

$$\delta = \max \left(\sum_{k=1}^{m_t} w_k \sum_{j=1}^{m_x} \frac{v_{kj} \pi_{kj}}{\sum_{i=1}^{m_x} \pi_{ki}} + \sum_{k=1}^{m_h} n_k \cdot h_k \right)$$

where $v_{kj} \in \{0, 1\}, \ j = \overline{1, m_x}$ – attribute of accounting for additional condition for teaching subject, π_{kj} – priority of the realized condition, w_k – weighting coefficient of teacher's rating , π_{ki} –priorities of complex of different conditions for corresponding teacher.

4. Development of model for automated system for timetable generation

Model of automated system (fig, 2) presents structural subordination of documents turnover in InMPGDDS to the common automated system , reflects functional mutual connection of agreed use of common resources.
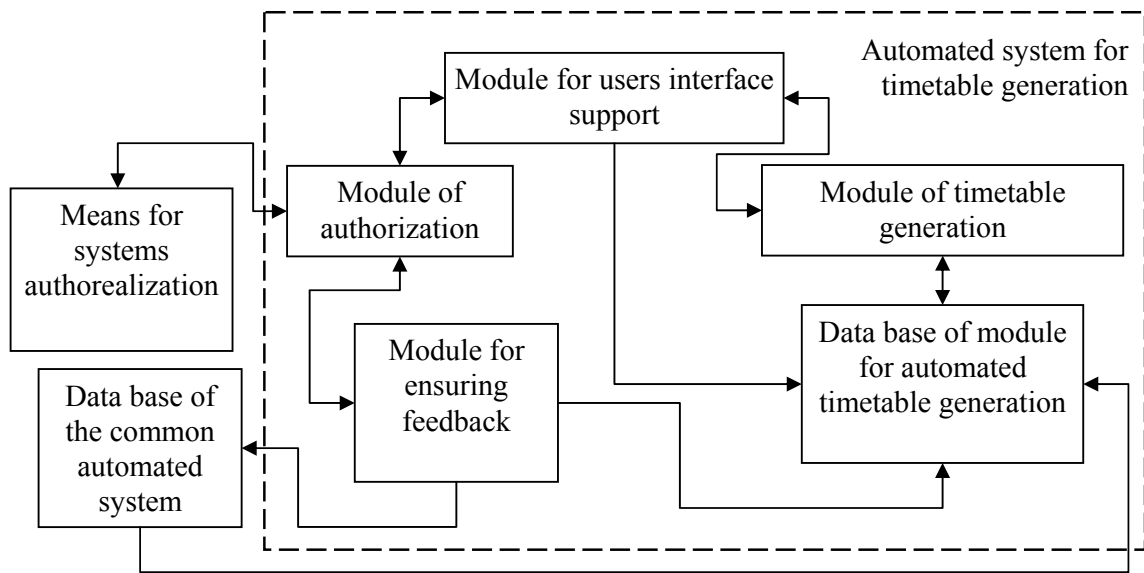
Fig. 2. Generation model of automated system for timetable generation

The result of the analysis of subject sphere is composition of structural diagram of data, which shows the main connections between the informative Tables (fig. 3)
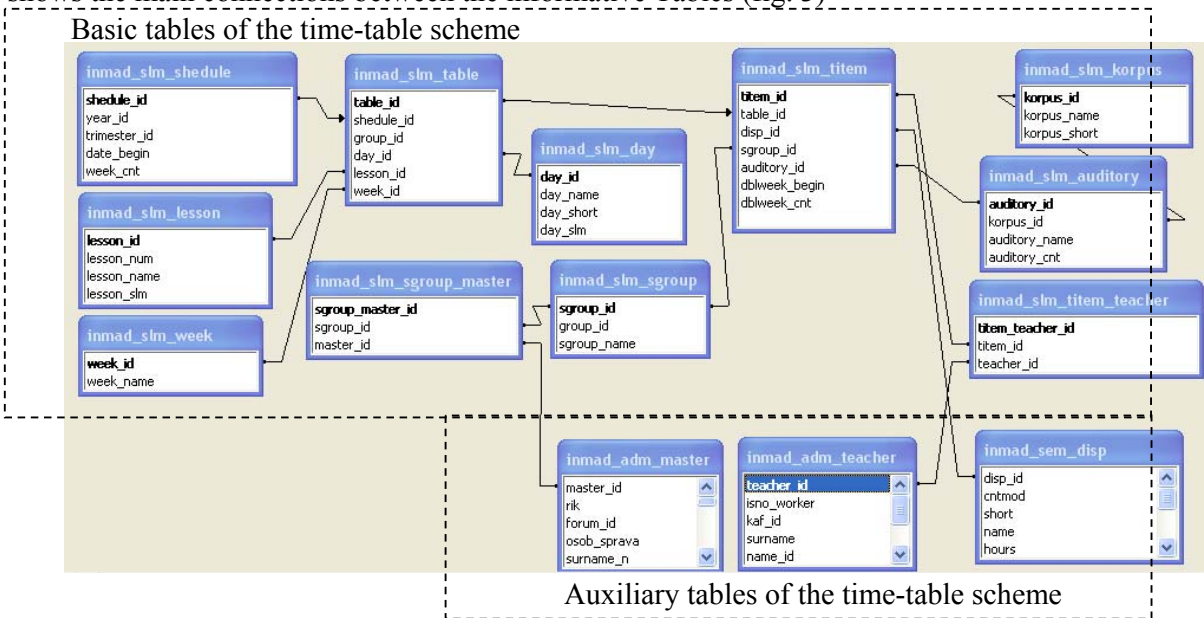

Fig. 3. Diagram of data and connections between informative data base

5. Development of system software

Realization of the main requirements to the formation of the software environment and ensuring interface is done using the technologies of cascading style sheets which allows the page marking within the frames of declarative character and ensures total control over the form of presentation of elements HTML-marking. Using cascading style sheets allows to solve discrepancies between accuracy in determining the sizes of pictures and attachments on the one hand and accuracy in determining the sizes of text blocks and its image on the other.

The developed styles are presented on the main page of the environment of automated system for timetable generation (fig. 4).
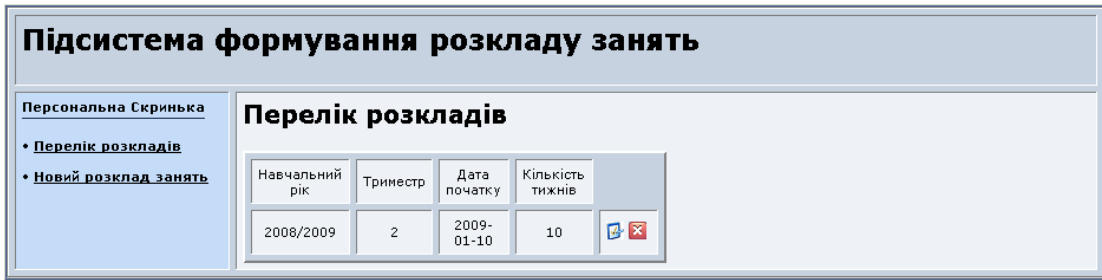
Fig. 4. Main page of the environment of automated time-table generation

The result of time-table generation by means of automated system of documents turnover is the created draft document (see fig. 5) which is to be further updated according to specific criteria, edited so to be exported to XLS – format upon the necessity.
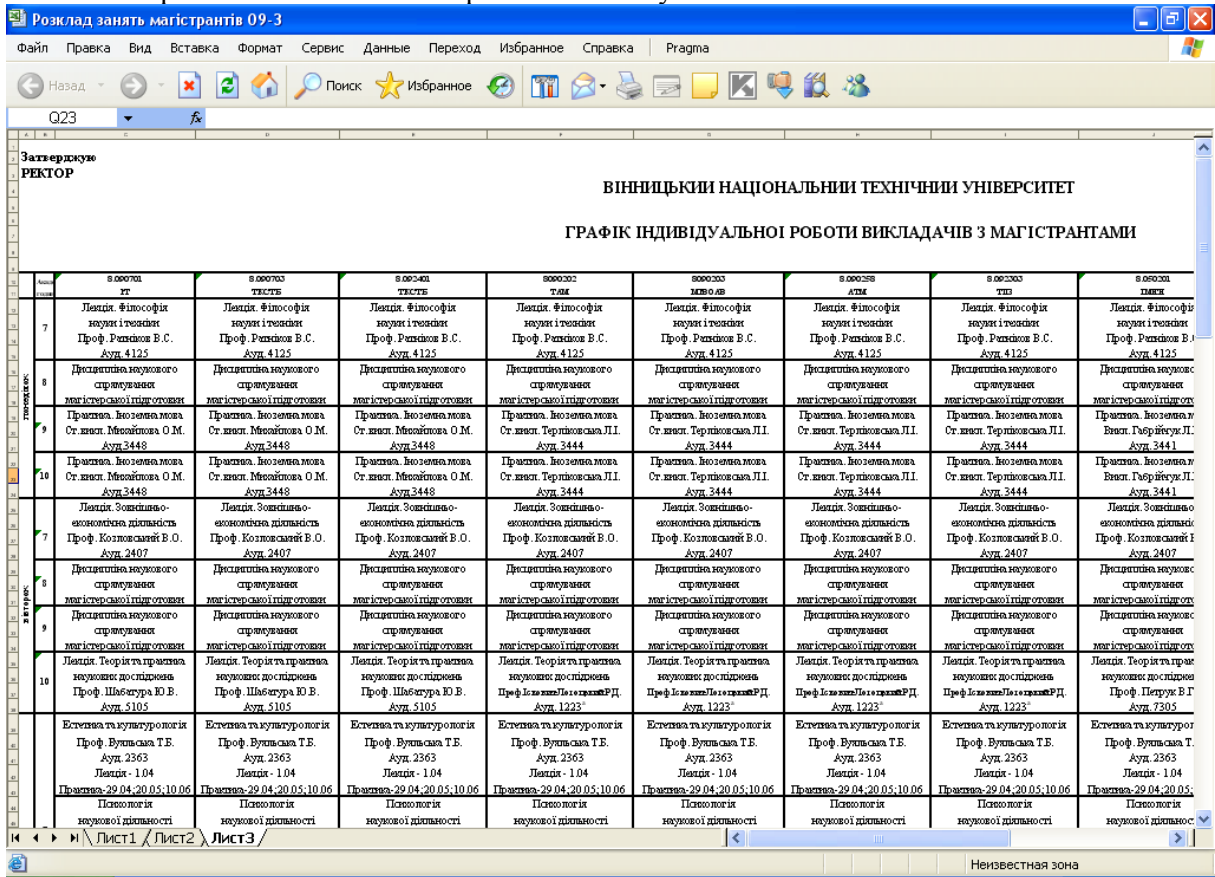

Fig. 5. Illustration of part of the generated time-table for Master students

Algorithmic sequence of realization of method for automated time-table generation for Masters training subjects is presented in the block-diagram of the diagram operation algorithm, shown in fig. 6.
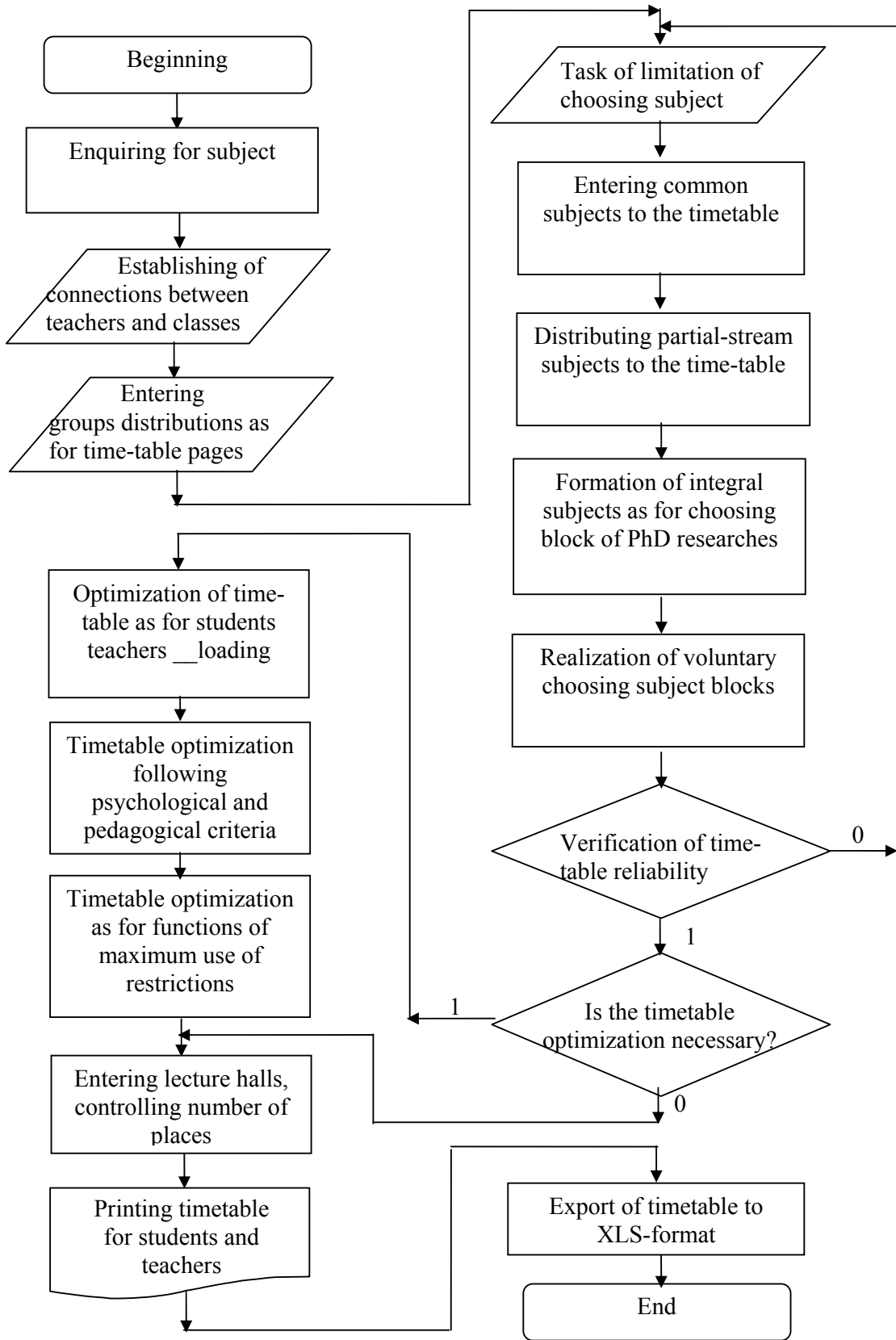
Fig. 6. Algorithm for realization of method for generating timetable for Master students

Realization of the developed model of the automatized system operating algorithm and method for timetable generation for InMPGDDS by means of target –oriented programming language PH.

Conclusion

The had been developed models for automated timetable generation for Master cources, which where realized in the environment of the automated documents turnover system, controlling and monitoring of training process of Institute for Master, Pos t Graduate and Doctor Degree studies in Vinnytsia National Technical University. Realized methods for automated timetable generation stipulates for requirements of Bologna process to generation of personal plans of Master students which accumulate blocks compulsory subjects, subjects for PhD researches which are chosen by students and which form the structure of integral subjects of specialities, as well as blocks of stream subjects of professional training according to post graduate cources specialities.

Module realization of the developed system of automated timetable generation in the structure of common automated system of documents turnover in the Institute of Master, Post Graduate and Doctor Degree studies ensure the possibility of common use of data base and introduction if common policy of protection of information provision of the system.

The development system was realized by means of modern net web-technologies aiming at automation of organizational processes and ensuring simultaneous remote access to information resources during formation of service documentation.

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