

# COMPUTER TEACHING OF MARINE SPECIALISTS WITH FUZZY LOGIC USING

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Higher education in marine industry is in the stage of reformation. A requirement to provide more high level of knowledge is replaced a requirement to prepare a specialist which would quickly adapt oneself in the world of changing technologies and would be in a state of continuous to study. Reforms especially actual in marine universities. Marine technologies develop so stormily, that not always is known, what technique a just acting student will work with. It determines new requirements to the graduating student: he owes not only to know and able but also no less important for him able to study. A teacher, in same queue, must not only hand on torches but also develop capacities for self-training.

Presently made first the advances in area of intellectualisation of teaching process and practically there are not the computer systems which possess so high intellect, that able fully to replace a teacher in all of variety of his educational communications with taught.

The traditional computer teaching systems do not either have a reverse communication channel frequently or are not in a position of adaptation of teaching process to the level of student's knowledge and abilities. Exposure of estimation during conducting of the computer testing on the basis of correlation of erroneous and correct answers, sometimes is not objective, because the amount of technical errors, not reflecting the level of knowledge of student is taken into account, for example, key pressed by mistake.

Rigorisms to the graduating students dictate introduction of the modern teaching systems on the basis of computer technologies. The real lecture is devoted using of apparatus of fuzzy logic for creation of the adaptive computer teaching system. We are developed an instrumental shell, which can be filled with different subject knowledge. The got computer teaching system is counted on independent work of student. The of principle feature of its functioning is a permanent reflection on that, how a process of mastering of material is.

The use of the apparatus of fuzzy logic makes it possible to solve the problems accessible for the experienced lecturer.

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Let us consider the variant of teaching scenario when a weak student solves suddenly a complicated problem. In this case the experienced lecturer will put some specifying questions and after this the knowledge of a student on this matter will become obvious and the possible ways for elimination of gaps will become be found. The intellectual teaching system shapes the activity of a coach that is the lecturer who is attentively watching the motion of the teaching process. The system possesses the information about the process of the teaching of this student that is it knows how conscientiously he has worked out this subject (theme), how long he was studying it, how many times he was coming back to the reference and previous material. That is why the conclusion about the further teaching is made on the basis of greater amount of information about the process of teaching the concrete student.

Let us consider the case when a student has proved a difficult theorem and at the same time he cannot solve and easy problem on the same material. In case of a traditional teaching a lecturer usually puts a specifying question and the results of the student on the given material become obvious.

The intellectual teaching program compares the number of wrong answers on theoretical and corresponding practical material and will draw a conclusion with the help of fuzzy logic whether the student should be proposed to read this material once more. An attempt to formalize the meditation as well as the action of the coach who is observing the process of studies of a concrete student is done in the present work.

This electronic teacher constantly reflexes the fact how the process of mastering the material is taking place, takes into consideration his individual peculiarities, knows the level of readiness to perceive the material, observes the time during which a student is studying the lecture, what questions are incomprehensible for him, tries to define the reasons of errors and offers the teaching trajectory for removing these errors and reception of further knowledge.

The process of studies can be considered as the process for controlling mastering of knowledge. This process is characterized by the aim for control (acquisition of knowledge), it has the object for control (student), the device for control as well as the feedback channel. The criteria of control quality are the results of knowledge control. When constructing such kind of systems the use of fuzzy controller has some advantages. First of all, describing the system instead of differential equation the knowledge of experts is used (lecturers at the black-board with the chalk in hand). This knowledge is expressed with the help of linguistic variables which are described in fuzzy sets.

In the second place there is some possibility to use operatively rich pedagogical experience and the possibility of tuning to any criterion of a mark.

The amount of knowledge on the mastered material is the value which is changing in time: during the teaching process this amount changes and after a certain period of time some details are forgotten.

It is impossible to estimate the amount of knowledge definitely.

In this case the most effective is the application of fuzzy logical conclusion of Mamdani type. For the construction of instrumental shell the methods of fuzzy modelling are used. Before the beginning of teaching we carry out the entrance control (test on the subject of the school course, the entrance mark or the average mark for the previous themes) depending on the place of this material in the process of teaching. The student is given the possibility to choose the level of studies.

Before answering the test task it is possible to address the previous or reference material. Then the practical part is studied: solving the tasks from the considered theme and the questions in the course of solving. The singularity of this chart consists in the fact that during the work of the student with the teaching system the meters also work: the number of addresses of a student to the reference and previous material, time spent for studying the material, meter of wrong answers on theory as well as the meter of the number of wrong answers on practice. It is very important to count the difference between the measure of wrong answers concerning theory and the corresponding practice, a part of wrong answers is fixed. The concluding control of knowledge after studying the theme on the theory and corresponding practice is carried out in the mode of the examination, that is the chart is the same but one should not refer to the previous and reference material and answer the same question.

When constructing the base of rules of fuzzy conclusion the reasoning is used the part of which is given at the beginning of the article. What will the lecturer do when he sees how the student who orient himself with the difficulties in the table of integrals brilliantly probes a row with the help of an integral sign. Naturally, he will ask to specify some moments in the solution. As for the teaching system in this case it will be easier to draw a conclusion because this student has a low potential of personality, low entrance control.

However, if this student spent a lot of time for studying this material, addressed very often the reference and previous material, gave correct answers to very many questions with the difference between the number of correct answers of theory and corresponding practice is not great, the system is going to draw the conclusion that there is no need to lower the mark, it will decide to proceed further. It is a different case if a student having a low input control did not practically read the material on the required theme, did not address the reference material, has great difference between the number of correct answers on theory as well as corresponding practice, the training system will propose to deal with this material more. The base of rules of fuzzy conclusion was made on the basis of pedagogical experience in estimating the knowledge of students and simply due to common sense.

By the time when the student has studied the theme the array of values for base variables is formed for the corresponding input linguistic variables. Then these values are fed to the fuzzy model for controlling the teaching process built in the environment of MATLAB (Fuzzy Logic Toolbox). After processing the data the value of base variable

corresponding to the output linguistic variable is given, is the estimation of the level of obtained knowledge.

On the output of the object of control after the completion of testing the clear values are measured (for example, on the theme A the correct answers are given, for k questions for the main notions of the theme, the correct answers for m questions reflecting the knowledge of mutual ties between the notions and n correct answers for the questions requiring the knowledge of mutual ties as well as the skill for drawing conclusions; and for theme B the corresponding answers v, g, f. The block of fuzzification will convert these clear values into fuzzy ones (for example, he knows something on the theme A and knows something on the theme B) with the help of linguistic variable values from the base of knowledge.

The block of decisions will transform the unclear input data into controlling influences which also have unclear character, for example to clarify the theme A, and as to theme B - to read the material a little). In this case the fuzzy conditions (if - then) are used, i. e. rules which are in the base of knowledge. Besides, in order to avoid the accidental setting of correct answers it is necessary to estimate the coincidence of the number of correct answers in accordance with the theoretical and practical parts of the theme.

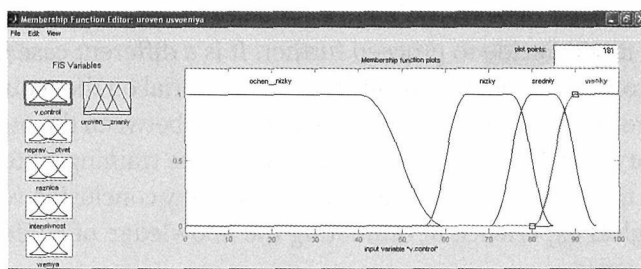
The block of defuzzification transforms the fuzzy data from the output of the solving block to the clear value (educational trajectory) which is used for controlling the object (for example, from the theoretical part of the theme A to read pages N<sup>o</sup> n - k, from practical part of the theme A to clarify the solution of the problems N<sup>o</sup> p, s, q).

The information about the amount of material studied by a student, about previous educational trajectory, results of testing and psychological peculiarities of a student personality are led to the fuzzy controller.

On the basis of this data the controlling influence is produced.

The type of functions belonging to the linguistic variable  $\beta_1$  – input control is shown at the picture.

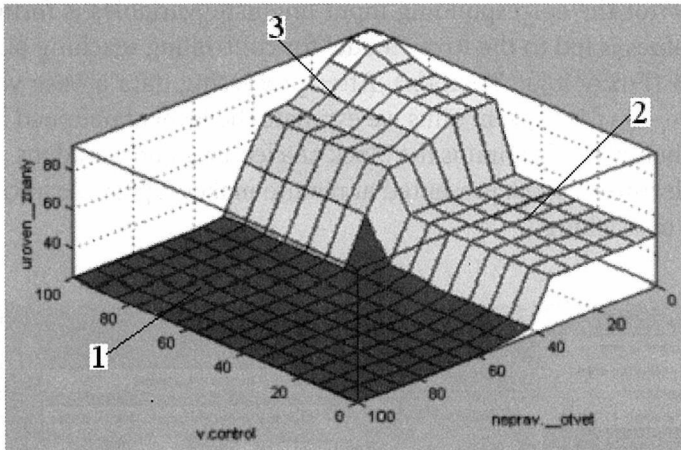
The chart of work of the teaching system with fuzzy logic: reading of measuring



devices in the process of teaching fuzzification, in other words, turn into fuzzy format, then processed, defuzzified and finally led to the actuating device in the form of usual signals. Thus, the teaching trajectory is proposed to the student in accordance with the level of his knowledge.

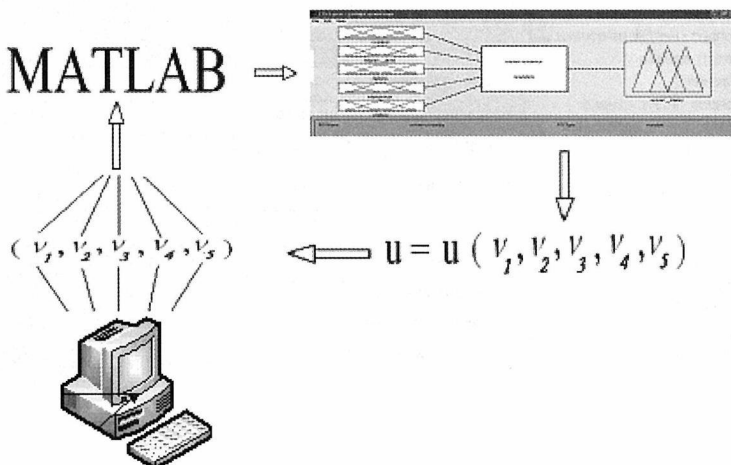
The surface of dependence of the level of acquired knowledge on the number of wrong answers as well as level of previous knowledge are shown at the picture.

The dependence of the level of the obtained knowledge on the input control and the measures of wrong answers are considered. Field 1 illustrates the fact that the student has got a bad mark, there the number of wrong answers is more than 40 with the arbitrary input control. Under these conditions the number of wrong answers is estimated in the same way.



Field 2 illustrates the fact that the student is not admitted for the estimation of his knowledge. In this case the input control is less than 60 with sufficient number of wrong answers in order to get the positive marks. In this situation when the traditional form of learning is used a student attends lessons and studies the material. However, he is not admitted by the dean’s office for passing the examination.

Field 3 is the fundamental one. It illustrates how the level of obtained knowledge depends on the input of control as well as the measure of wrong answers.



In the teaching program "Teaching expert" the realization of the level of obtained knowledge was considered where the linguistic variables were dealt with: level of mastering, input control, time spent for studying, difference between the wrong answers on the theory and practice, part of wrong answers number of addresses to reference and previous materials. We note that all the linguistic variables are characterized by the measured properties.

After a student has studied the theme a cortege of values of base variables  $(v_1, v_2, \dots, v_5)$  for the corresponding input linguistic variables is formed. Later on this array of values is fed to the fuzzy model for controlling teaching built in the medium MATLAB (Fuzzy logic Toolbox). After processing data a base variable value  $u = \omega (<v_1, v_2, \dots, v_5>)$  is given. Thus we estimate the level of obtained knowledge.

The instrumental shell contains the block of a lecturer and a student. The program module of the lecturer's block presented at picture makes it possible to create and correct the course of teaching.

The screenshot displays the 'Teaching expert' software interface. On the left is a tree view of the course structure under the menu 'Файл' and 'Справка'. The tree includes items like 'питання 2- обмеженість', 'питання 3- необхідна ознака', 'питання 4- гармонічний ряд', 'питання 5', 'питання 6- порівняння і Даламбер', 'питання 7- ознаки Коші', 'пр. питання 1', 'пр. питання 2', 'пр. питання 3', 'пр. питання 4', 'пр. питання 5', and 'пр. питання 6'. The right side of the interface is divided into three configuration panels:

- Тема (Topic):**
  - Название: питання 3- необхідна ознака
  - Файл темы: C:\Мои документы\Новая папка\необхід...
  - Попыток ответа: 1
  - Раздел:  Теория  Практика
- Вопрос (Question):**
  - Название: необхідна ознака
  - Правильный ответ: A
  - Вес, %: 10
  - Вес в группе, %: 15
  - Раздел:  Теория  Практика
- Курс (Course):**
  - Название предмета: Ряди
  - Название модуля: Числові ряди
  - Автор курса (ФИО): Вишневська В.М.
  - Файл журнала: C:\Мои документы\Новая папка\ЖУФ...
  - Файл FIS: D:\Documents and Settings\Leon\Desktop...
  - Файл справочника: C:\Мои документы\Новая папка\СПР...
  - Max интенсивность: 25
  - Max время (обучение): 270
  - Max время (экзамен): 90



The screen form of the mode of teaching is presented in the following figure:

ФИО: Z Предмет: ВМ  
 Курс: 1 Модуль: ПРОИЗВОДНЫЕ  
 Группа: d Тема (раздел): Усл. существ. произв. обратн. функции

**ВОПРОС 1**

Укажите условия существования производной для функции, обратной функции  $y = f(x)$ :

А) функция  $y = f(x)$  ограничена, непрерывна на  $(a, b)$  и имеет неравную нулю производную  $f'(x)$  в произвольной точке этого интервала;

В) функция  $y = f(x)$  непрерывна, строго монотонна на интервале  $(a, b)$  и имеет неравную нулю производную  $f'(x)$  в произвольной точке этого интервала;

С) функция  $y = f(x)$  ограничена, непрерывна на  $(a, b)$  и имеет неравную нулю производную  $f'(x)$  в произвольной точке этого интервала;

Д) другой ответ.

Ответить на вопросы

Вопрос № 1

Следующий

Варианты ответа

A  
 B  
 C  
 D

Информация

Вы ответили НЕ правильно! (Правильный ответ - В)

ОК

Ответить

Справочник      Ответить на вопросы      Пауза      Продолжить

The obtained instrumental shell of the teaching system has a universal direction and can be used in different fields. The use of the given teaching system in higher educational establishment will make it possible to provide the personification of the teaching progress. Such system can be used for teaching students at extra- mural courses as well as for the subject courses.

The use of algebra of fuzzy sets provides the possibility to form the charts of logical conclusion for the estimation of the level for mastering the knowledge of the trainees. In this case the base of knowledge of the rules of fuzzy conclusion possesses the property of universality which can be used for a great number of education subjects.

The program is written on the C++ programming language and requires following resources of the personal computer: RAM - 32Mb, HDD - 1Gb, processor-300MHz.

Our personal experience and the analytical researches of home and foreign developments show that at present time the first steps in the field of intellectualization of the teaching process are made and practically there are no computer systems which possess such a high intellect which is able to substitute a lecturer completely in the whole variety of the education communications with the trainees. The values of the traditional education are indisputable, however indisputable is the value of the intellectual teaching systems which help the teachers and the trainees to work more effectively and successfully while gaining knowledge.