HIERARCHICAL DECISION MAKING FOR EDUCATION IN INFORMATION ENGINEERING

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Abstract

The paper describes the use of hierarchical decision making in information engineering on the base of the following: (i) multicriteria description and analysis of main components (hardware, software, algorithms, etc.); (ii) basic discrete decision making problems (multicriteria selection, multicriteria composing (synthesis) of composite systems from elements with taking into account their compatibility) (e.g., compatibility of software and hardware elements, compatibility of software and personnel); (iii) synthesis (integration) of information systems. We propose a teaching framework, an approach to teaching at several levels, and a description of our course for students-managers.

1. INTRODUCTION

The paper addresses educational issues in information engineering on the base of the following components:

1. Generalized glance to information technology as a Cartesian space on the base of two axes: (a) main components (models, algorithms, software, hardware, communication, information systems, personnel), and (b) stages of product life cycle (research and development, manufacturing, marketing and sale, maintenance and utilization, re-engineering).

2. Multicriteria description of elements of above-mentioned cartesian space (e.g., marketing of algorithms, re-engineering of information systems);

3. Basic discrete decision making problems as follows [5]: multicriteria selection, multicriteria composing (synthesis) of composite systems from elements with taking into account their compatibility (e.g., compatibility of software and hardware elements, compatibility of software and personnel).

4. Synthesis (integration) of information systems including evaluation of components and their interconnection, integrated evaluation of composite systems [3].

2. PROPERTIES OF INFORMATION TECHNOLOGY

Information technology (IT) differs from traditional technologies oriented to processing a raw material. Basic phases of information processing are the following: (a) accumulation of data, knowledge acquisition; (b) maintenance of data/knowledge bases; (c) transmission of information; (d) processing including routine one, and intellectual one; (e) presentation of information; (f) utilization.

In our opinion, it is reasonable to point out the following properties of IT: (1) various types of information sources: (i) objective ones (statistical data, books, newspapers, data bases), and subjective ones (specialists, representatives of various groups of population); (2) preservation of initial information and the possibility of re-processing; (3) possibility of concurrent processing; (4) possibility of the use of different processing methods; (5) possibility to accumulate results (output); (6) high ecologability; (7) high requirements to professional skills; (8) unique role of the human; (9) high requirements to a level of information presentation, and human-computer interaction; (10) interaction among exact sciences (mathematics, computer science) and engineering (e.g., communication systems, software engineering), on the one hand, and humanistic sciences (psychology, education, human engineering) including, art as painting, cinema, TV-industry, on the other hand; (11) wide range of consumers as follows: (a) science; (b) industry; (c) management, economics, finance; (d) education; (e) art; (f) private life.

3. TEACHING FRAMEWORK

A framework of teaching process consists of the following main parts: (a) students; (b) objectives; (c) support tools; (d) process of teaching.

Let us point out basic components of a course and corresponding support tasks (in brackets):

1. Analysis of goals (generation of conceptual goals).

2. Analysis of students (classification and modeling of students, generation of requirements to students, etc.).

3. Course elements (selection of elements).

4. Structure and schedule of course (design, scheduling).

5. Presentation of course elements (selection and design of presentation techniques).

6. Support tools (selection and design of support tools, for example, print material, software, environments).

7. Course tasks, projects (selection or design, forming of student teams, etc.).

8. Evaluation of skills and knowledge (selection/design of test operations, programs).

In our opinion, it is reasonable to consider the following basic types of target specialists (roles) as education goals: (1) engineer-designer of IT components (software, hardware, communication, data bases, knowledge bases, mathematical models); (2) system engineer (designer of new unique composite systems, specialist in system integration). (3) engineer-specialist in maintenance; (4) specialist in system integration from the side of user; (5) user.

In addition, we may point out types (or levels) of IT as follows: (a) IT components (hardware, software, communication systems, information, etc.); (b) composite systems from IT components; (c) applied IT systems. Note that the types are corresponded to creative levels, proposed by Altshuller (e.g., use of an object, choice of an object, modification of an object, design of a new object, design of a system of objects) [1]. In addition, at the same time, we try to take into account elements of systems engineering ([10], etc.).

And now we can analyze a relationship of the basic levels and roles above. Note that there exist many excellent courses oriented to certain goals (i.e., IT level and role), for example, the course of Turban is the basic one for students in management to acquaint with information systems, expert systems and decision support systems (DSS) [11]. An attempt to describe basic IT components and their integration is contained in [4].

4. BASIC PROBLEMS AND LEVELS OF TEACHING

In our opinion, teaching of complex problem solving is very difficult problem. It is very important when we have got students who can work and think only at the levels of certain objects and discipline-dependent descriptions.

Let us consider basic problems in the field of information engineering as follows:

(1) multicriteria description and analysis of IT components;

(2) comparison and selection/choice of IT components;

(3) composing of several IT components into a whole system with taking into account quality of element and their compatibility (interconnection);

(4) assignment/location of IT components in a network.

These problems may be examined at different formal levels as follows:

(1) user's level (choice of a decision);

(2) engineer's level (mainly, conceptual description, design as a modification);

(3) mathematical level (mathematical modeling).

Finally it is reasonable to examine the following three basic strategies of teaching for three types of students as follows: economists or managers/users; engineers/developers of IT components; systems engineers. And in our opinion, we can use several basic combinatorial models for the analysis and/or synthesis of IT components, i.e., discrete decision making problems ([3], [7], etc.) for teaching of basic problems above (multicriteria description and analysis of IT components; comparison and selection; composing; assignment/location of IT components).

5. COURSE FOR STUDENTS-MANAGERS

Our course involves the following:

(1) generalized system material to acquaint with the contemporary development, marketing, utilization/maintenance of IT;

(2) to acquaint with IT components (hardware, communication systems, main types of software packages, mathematical modeling, etc.) on the base of multicriteria descriptions, multicriteria comparison of alternatives for the above-mentioned IT components.

The multicriteria analysis and comparison of alternatives for IT components allows to teach basic requirements to main IT components. In our course, the multicriteria analysis was implemented on the base of DSS COMBI-PC (IBM-PC) [2]. The course was oriented to system integration (to order IT components, to organize a competition and complex evaluation of IT systems).

The program consists of the following 9 parts:

Part 1. Introduction: IT components, properties of IT, bottlenecks, real-time systems and their applications, DSS COMBI.

Part 2. Paradigm of decision making and DSS (classification of problems by H.Simon, stages of decision making, realistic examples of multicriteria analysis).

Part 3. Data bases, hypertext systems, multicriteria analysis and comparison of systems.

Part 4. Knowledge based systems (structure, approaches to knowledge representation, stages of developing the knowledge based systems, multicriteria analysis and comparison of the systems).

Part 5. Hardware, communication networks (types of computers, e.g., PC, workstation, mainframe; scheme of data processing in communication networks, examples of applications in banks, management of communication networks, multicriteria analysis and comparison of computers, communication systems).

Part 6. Human-computer interaction (structure, example of human-computer systems, human limitations in the information processing, user modeling, user interface adaptation, evaluation of human-computer interaction).

Part 7. Mathematical modeling, optimization software packages (structure of the systems, types of mathematical models, examples of systems, comparison of the systems).

Part 8. Distributed systems (distributed data bases and DSS, group and cooperative work, multi-agent systems, application examples of distributed systems).

Part 9. Design of technologies (system integration, evaluation of components and their interconnection, integrated evaluation of composite systems, location of IT components).

In addition, our course includes tasks for each student at the following two levels/stages:

(1) solving of several local problems of multicriteria analysis/comparison of IT components (with the use of DSS COMBI);

(2) composing of several IT components into a whole system (multicriteria selection of alternatives for several IT components, and system integration).

The tasks above are based on the extended example, which was described in [4]. Our students prepare their results as a report on floppy disks. Each student can obtain DSS COMBI on floppy disk to solve the problems at home on his/her own computer.

Note, at the second stage, some local parts of students tasks are common ones, and it stimulates communication between students. Clearly, the above-mentioned education scheme may be implemented as a distance education process.

6. CONCLUSION

Let us note the significance of re-engineering of information systems. In this case it is reasonable to examine the special approaches to the analysis and improvement of complex systems including the following: description, revealing of bottlenecks, generation of improvement actions, evaluation, etc. ([8], [9]). And in addition, we have used hierarchical decision making for the following problems in the field of education:

(a) planning a career for students (analysis, selection and composing of educational elements, sport elements, etc.);

(b) design of an education course (e.g., for teaching of hierarchical decision making).

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