DECISION SUPPORT SYSTEM FOR CHOOSING THE OPTIMAL CAD CONFIGURATION: GENETIC ALGORITHM APPROACH

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Abstract- This paper presents the development of an information system for Decision Support System (DSS) for optimal Computer Aided Design (CAD) system configuration. The genetic algorithm solution has been considered. The architecture of a decision support system is represented.

Index Terms- CAD, CAD system configuration, decision making, methods of optimization, genetic algorithm.

I. INTRODUCTION

Computer-Aided Design (CAD) is the use of computer technology for the design of real and virtual objects. CAD is an important industrial art extensively used in many applications, including designing and producing electronic systems ranging from printed circuit boards to integrated circuits, automotive, shipbuilding, industrial and architectural design, and many more [1-5]. Currently, in the process of designing CAD systems, it must continuously make difficult decisions, associated with many criteria and factors [6]. Such decisions cannot be taken only with the use of intuition and experience of the project manager. It's complicated and time consuming to examine all possible options for system configuration and make the best choice. Therefore, it becomes necessary to develop and implement formal methods of a decision support system (DSS). Using a DSS in designing CAD system allows not only to obtain more accurate results on the problem being investigated, but also to optimize the process and reduce labor costs [7]. The modern process of designing the network infrastructure - is one of the fastest growing sectors of the industry. This is due to the fact that at this stage of development of local area networks in their characteristics and capabilities more fully meet the needs of a large part of institutions and enterprises involved in the planning, management, production and other spheres of activity. This paper is organized as follows: first, we demonstrate an overview of CAD, followed by the DSS overview. Then DSS genetic algorithm is presented. Finally, we provide a conclusion.

II. DECISION SUPPORT SYSTEM

The DSS to select the optimal configuration of CAD network infrastructure is based on the interaction of two modules: optimization module and simulation module [8]. The scheme of DSS is shown in figure 1. The optimization-based simulation lies on the sharing of the simulation module of complex systems and algorithm optimization. With the help of the simulation module, the response value for different combinations of value factors that proposes an optimization algorithm can be calculated. Using the response value, the search engine of the optimization algorithm, in turn, attempting to improve the solution.

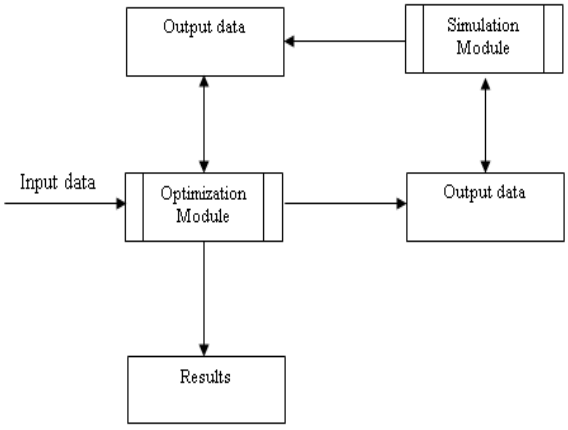


Figure 1. The work of the DSS.

The work of the DSS (see figure 1) represents a cycle consisting of a set of sequential operations [7]. Key elements of this scheme are the optimization and simulation modules. To organize the process of interaction between them, we created two text files: "Input data" and "Output data". Their main task is to organize data exchange between the two modules of the DSS. The arrows in the diagram show the steps for the input, store, read, conclusion, and the manipulation to the data. Initially, the data are fed to the optimization module, which puts them in a file "input data". Further simulation module accesses this file and reads the data, which are then used to implement a simulation of the design process network infrastructure. Upon completion of all calculations, the simulation module records the values obtained in the file "output data". The next step is to optimize the treatment module to the data and reading them from a file. The data obtained are analyzed within a block using the genetic algorithm, and depending on the result a decision to stop or continue the process will

be made. If the result is not optimal, then the process starts again, but in the file "input data" is written with transformed genetic algorithm values. If stop criterion works, then the process stops, and the optimum results will be displayed on the screen.

III. THE PROPOSED GENETIC ALGORITHM

As a method to implement the DSS, a genetic algorithm was selected. Activity diagram of the genetic algorithm is shown in figure 2. We describe it in detail each step of the genetic algorithm in terms of implementing programs to support the decision to select the optimal configuration of CAD network infrastructure.

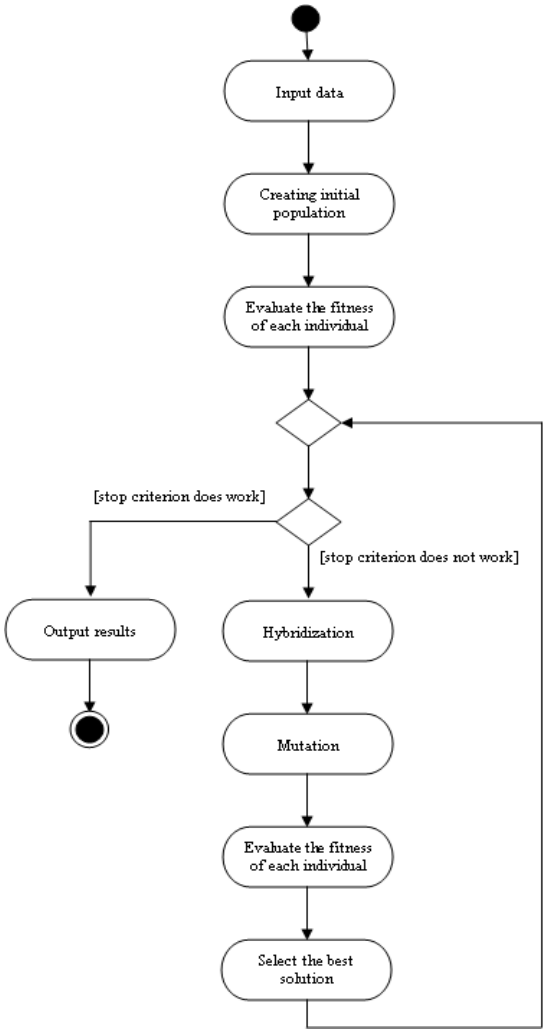


Figure 2. UML Activity Diagram for decision making algorithm.

Creating initial population: The data entered by the user in the program to start the process of modeling the network infrastructure is used for the formation of the first chromosome. Components of chromosomes (genes data) are arranged in the following order:

1. the number of staff who will be involved in the development of a local computer network;
2. the number of users in the local network project;
3. the importance of the safety criteria (from zero to 10);
4. the importance of the criterion of performance (from zero to 10);
5. the importance of the criterion value (from zero to 10);
6. the importance of the criterion of convenience (from zero to 10);
7. setting the organization access to the Internet (0 - no access, 1 - access is limited, 2 - full access);
8. setting training for users (0 - No, l - yes);
9. setting organizations supporting the work of the implemented network infrastructure (0 - no, 1 - yes).

Thus, one chromosome is created, which it is not enough to start the work of the genetic algorithm. So from the original chromosome using a mutation operator a few individuals are created. As a result, a set of chromosomes forms the initial population.

Evaluation of fitness of each individual: At this stage, it is necessary to evaluate the fitness of each individual, so that eventually for the subsequent operation of crossing were selected "best". To do this, for each chromosome (a set of parameters) is called the simulator and individuals to sort in ascending order value, which is subject to optimization (time or cost). As a result, at the beginning of the sorted list will be the fittest individuals, i.e., the CAD configuration of network infrastructure, which correspond to fewer time projects or lower costs for its implementation (depending on the chosen pair of feet optimization).

Hybridization: At this stage the cross "best" of selected individuals. As a result, we obtain a new population - the descendants of earlier species (a new set of sets of configuration settings CAD).

Mutation: The population created in the previous step exposed that the mutation operator for the emergence of new solution can be promising. For this, each chromosome randomly selects a position (gene), in which the value is changed. Produced changes are directional, that is, the process of mutation depends on the selected optimization parameter. Depending on this mutation the value of the CAD configuration parameter changes, as to reduce the final result for the selected optimization parameter.

For example, consider the option, when a random position of chromosomes, which undergo mutation, was selected first (number of employees involved in development). If a time was selected as optimization parameter, then the number of employees should be increased (as more employees, the project will be executed faster). If a cost was selected as optimization parameter, then to reduce expenses it is necessary to reduce the number of employees.

After the mutation operator completed its work, it is necessary to evaluate the fitness of each individual in

the new population. Select the best solution: After creating a new population by means of crossing and mutation it is necessary to choose "best" individual (i.e., the best option on this configuration, CAD iteration of the genetic algorithm). The necessity of this step is the formation of the stop criterion of the algorithm. Procedures for crossing, mutation, fitness evaluation, and selection of the best solution are repeated until the stop criterion works. The stop criterion uses a certain conditions as follows: if the difference between the best solution at the current time and at the previous iteration is insignificant or performed the maximum number of iterations, then the algorithm stops its work. The last best solution founded is the optimal configuration of CAD network infrastructure.

CONCLUSION

The paper proposed a solution for the implementation of DSS for optimal CAD system configuration. The implementation of the genetic algorithm was described in detail. The proposed algorithm was implemented using MySQL and Java programming language.

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