Algorithm Alterable Models and APL

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ABSTRACT

The paper deals with a software development of a certain kind of economics systems models: algorithm alterable models. The special feature of algorithm alterable models as follows: a research work with the model gives new knowledge about the modelling system, that cause a necessity to change the model itself. After changes this cycle is repeated. APL is mostly suitable for a development of the alterable models software. A method of the development is discussed in the paper as well.

As an example the paper outlines a modeling of a long-term planning process in a capital construction. A corresponding software - DSS for the planning - is described. The DSS had been implemented in APL 2.0 on a CDC Cyber-172 mainframe in LIIAS USSR. So called, pseudo-parallel executions, combined APL with ALGOL and FORTRAN subsystems, have been developed to improve dynamics characteristics of the DSS software.

Introduction

In the beginning of 80s in Central Research Economic Institute and Leningrad Institute of Informatics and Automation of the USSR Academy of sciences the research work has been started dealing with long-term planning in capital construction in the frame of an economical region. The planning is very specific under the conditions of the socialist economical system. The average time necessary for erection of a building is about 3-5 years and the structure of the work can be considerably redistributed upon the period of construction. The procedure of planning itself is being changed during this period too. Under these conditions continuous replanning of the production program of building companies takes place; the accomplishing of permanent alterations in planning with the existing methods is extremely difficult.

Our attempts to make a model of an existing planning process had certain results which can be of common interest in the field of modeling of systems which are unsatisfactory in formalization.

First of all, we were made to abandon the attempt of building the formal mathematical model because of the absence of sufficient relevant information. That's why we used algorithm models for this purpose. Secondly, we should use the models which are easily alterable and adaptable. Thirdly, the models should be interactive to consider the unformalized information. And finally, our knowledge about the real system were not homogeneous which cause that in some cases we could use mathematical optimization and in other cases we could use only approximate heuristics. It's quite clear that there were a lot of requirements concerning the software of the modeling. Now, when the work is finished we could say for sure that it was a success due to the application of APL.

ALGORITHM ALTERABLE MODELS

As models of economical systems and processes Functional Algorithm Models (FAM) were most often used which can be defined as the models unchangeable in the process of their employing and which serve for getting the quantitative information about the model investigated. The term "algorithm" in their name shows particularly that the model is the totality of data andalgorithms realized on a computer. FAM are designed under the conditions when all the common requirements to modeling are satisfied: the possibility of observing, stability, extrapolation, finiteness and

coordination. The main shortage of FAM is the fact that they require the full "definiteness" of thesystem investigated and are unchangeable in the process of investigation (in any case, all the alterations are connected with difficulties). This fault considerably limited the field of FAM application.

That's why it is extremely important for automation of investigations in planning to create a flexible tool which could be developed and modification in the process of accumulating knowledge about the object of investigation, i.e. in the process of investigations themselves. The technology of creation of this tool is of importance too. As the tool described we suggest to use the Algorithm Alterable Models (AAM), i.e. models which are being changed in the process of exploration and serving forgetting both quantitative and qualitative information [1]. AAM are established under the condition that the requirements for observing and stability are not fully satisfied.

The technology used for the establishing of AAM complex gives the possibility to take into consideration a characteristic feature of these models: the development step by step, the necessity of accounting factors which are not simple in formalization, unsatisfactory expressed structure of a object being modeled. The characteristic features if the technology used are:

1) the design "from the bottom to the top"
2) automation step by step (form task to task).

First of all, we work out a Local Algorithm Model (LAM) for every task (fragment of a process being modeled or a system) which requires automation (if it is possible to formalize it). LAM can be established on different levels of an abstract representation of the object being modeled. The possibility to formalize of a fragment being modeled gives the opportunity to use both traditional methods of algorithm models establishing and different systems of automation of modeling.

LAM fulfilled on a computer can be used autonomously for getting new data and knowledge about the system being investigated. The set of models of this kind is used by a user (who is an expert in a particular field) in accordance with the order of payments accepted in the real system.

Then, the local models are complexed into an enlarged model by means of introducing a planner of calculations. The planner is modeling the order of the usage of local models for estimation of the plan variants. Upon omission the planner realizes a certain initial order of estimations. According to the user's commands (from the terminal) the planner can change this order both in the enlarged model and in the local one.

As a rule, we use heuristic algorithms in models, but in cases when the local task is simple enough for formalization, we use optimization methods. Algorithms used in LAM normally give the permissible solution of the tasks, therefore we use multi-variant calculations with subsequent automated evaluation of variants and the choice of the best of them for getting the final plan of the higher quality.

SOFTWARE FOR AAM

Projecting "from the bottom to the top" has certain negative features. They appear at the stage of complexing the program realizations of local models: objective difficulties of joining upon data and control. To escape these difficulties we use the technology of design of the software including:

1) cycle procedure of the design software
2) design of softwareas instrumental set of modules corresponding to the local models
3) the usage of the instrumental set for isolate processing of global data arrays by every module
4) the usage of a programming language of superhigh level.

As a programming language APL is mostly suitable for AAM due to:

1) the best relation between the time necessary for design work and the efforts required for the design
2) ready interactive environment which is quite satisfactory for building the open systems
3) convenient means of saving-restoring the medium (#SAVE, #LOAD, #COPY) which are necessary for operations like Undo and What-If.

The cycle design was described by S.Taylor and K.S.Andersen in the work [2] concerning the budgeting of large APL-projects. Nevertheless, their fast-cycle method is suitable for working out of software of unsatisfactory defined systems.

The design based on principle "one model - one module" is quite natural. What is very important here, there is the possibility to use the module autonomously in open system or just in APL environment. The analysis of the usage of modules given by the user could give very important information for adjusting the planner of calculations.

We should point out some facts in the relation AAM software.There appear some moment in the development of many AAM when a model isn't being developed any more. It becomes functional and can be realized on a computer more effectively. On the other

hand, APL language often is not suitable for some algorithms of calculation. And, there are cases when the user would like to insert an existing model made, for example, in FORTRAN, in the complex being designed.

For all the said cases the author designed a method which is called pseudo-parallel calculations [3]. The method is based on the original procedure of program starting tasks of operation system (OS), observing their status and data exchange between background APL-program and autonomous OS tasks, from program system APL 2.0 [4]. This method gives the possibility to establish complexes of programs in which programs are functioning without direct participation of an operator; these programs being managed only by the main APL-program use any software of the OS. It gives the possibility for any separate algorithm to be realized very effectively. The usage of pseudo-parallel calculations is very good coordinated with the cycle design of software.

THE PATTERN OF A REAL SYSTEM

In the frame of the technology described we fulfilled the realization of AAM complex of planning concerning the capital construction. The task of forming the plan of capital construction consists of several parts. The procedure of distribution of orders on construction between building companies on the territory of a large region for five and more years is the most important part of the task. As a mathematical one, it is multicriteria task of square, partly integers programming with zero-one variables [5]. To solve the task precisely is not expedient, taking into consideration the lack of information and the necessity to recalculate the plan for many times. That's why we designed AAM complex for planning.PLAN84 was made in APL 2.0 system for investigations as the instrumental set of modules: local algorithm models, modules for evaluation and presentation of information (more than 200 functions).

On the basis of PLAN84 system we worked out a decision support system (DSS) while planning the distribution of objects to be constructed between building companies in the region: PROPLAN. Comparing with PLAN84, DSS is supplied with the interpreter of dialogue language with the user. The interpreter also provides the functions of the planner of calculations. The system works on computer CYBER-172/6 in Leningrad Data Processing Network of the Academy of Sciences and is available from terminals and PC connected to the Network by standard means.

The code volume of the kernel of the PROPLAN system on APL is more than 30,000 words of CYBER-172/6 computer. There are fragments of the system (using the object modules which were received by translation from FORTRAN and ALGOL) realize optimization algorithms. If necessary, the system makes alterations of the source text of FORTRAN-program, its compilation and substitutes the old object module with a new one.

CONCLUSIONS

The planning task described in the article refers to the category of multicriteria tasks of distribution of homogeneous source in space and in time. The algorithm and software designed can be easily used for solution of other similar tasks.

The part of the software is made as autonomous packages of APL programs. It refers both to utilities providing the pseudoparallel calculations and to implementation of evaluation method of several objects which is fulfilled by one expert using random set of parameters; as a result the expert chooses the best object upon the totality of parameters.

As a further stage in development of the investigations described can serve DSS for production planning of a building company; the DSS is being made in APL*PLUS system on the PCs of IBM AT clone.

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