Data Structure and Application

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Abstract. This paper expounds the concept and status of data structure from how the computer solves the practical problems through program design, based on the analysis of the connection and difference between data structure and algorithm, the general principles followed by data structure are given, and further illustrates the practical significance of data structure application through examples. Data structure is the logical structure of data, the physical storage structure and the encapsulation of algorithm. This paper discusses how to apply data structure to solve the practical problems of non-numerical calculation from these three aspects and illustrates the application of data structure with a concrete example.

Key words: data structure; program; algorithm.

INTRODUCTION

Nowadays, computer is an indispensable tool for the production and life of human society. Computers not only help us to solve many numerical problems in engineering and scientific calculations, but also can help us to effectively solve plenty of non-numerical calculation problems such as text processing, information retrieval, data management, image processing, video processing and artificial intelligence. The mathematical models of numerical calculation are various equations and solutions, and the mathematical models of non-numerical calculation are the content of data structure application. Therefore, data structure is the foundation of computer science. From the division of disciplines, it is the core curriculum of operating system, database, compiling principle and computer networks and other kinds of professional basic course, and computer graphics, image processing and artificial intelligence and so on, which plays the role of the core course in the computer course system.

MEANING OF DATA STRUCTURE

Data structure is a kind of data element set which has certain logical relation, uses some kinds of storage structures in computer, and encapsulates corresponding operation. Data structure contains three aspects of content, logical relationships, storage relationships and operations. The logical structure of data can be divided into linear structure and nonlinear structure roughly. A one-to-one relationship exists in the data elements of linear structure, except the first and the last node; any other node has only one direct precursor and descendant node. Linear structures include linear tables, stacks, and queues. The tree, set and graph are all nonlinear structures, in which the tree structure simulates level, and the graph structure simulates symmetric and asymmetric relation. The research data structure is the need of program design to make the program design more robust and efficient, and the development of the program more convenient.

IMPORTANCE OF DATA STRUCTURE

When using a computer program design solve a practical problem, the following basic steps are generally required: requirement analysis, establish mathematical model, select computer language, program, test, and final answer.

Computer program design solves specific problems, the most important and core is to abstract the actual problem to the mathematical model. In order to establish a mathematical model of the problem, we must first find out the characteristics of the object to be processed and the relationship among objects (namely analyze structure between data), and it is the logical structure of data objects; at the same time, the process of design algorithm and program implementation must determine how to implement the operation of objects, and the operation methods determine the storage structure adopted by the data. Therefore, the logical structure and storage structure of data will directly affect the efficiency of the program. The logical structure and storage structure of data is the content to be studied in this course. Thus, data structure is very important in program design.

CONCEPTS OF DATA STRUCTURE

(1) Related concept of data structure

Data structure describes data to be processed according to certain logical relations, which involves the logical relationship among the data, the storage and operation of data in the computer.

(2) Relationship between the data structure and the algorithm

N. Wirth proposed: program was composed of algorithm and data structure.

The above illustrates the following two problems: (1) the algorithm on the data determines how to construct and organize the data. (algorithm→data structure), (2) the selection of the algorithm relies on the data structure as the foundation (data structure→algorithm).

Algorithm is a description of the process of solving a particular problem, which is a finite sequence of instructions, and it is the specific and limited operation steps taken to solve a specific problem. The program is an implementation of the algorithm, and the computer implements the algorithm step by step to solve the problem.

The program can be regarded as a combination of computer instructions, which is used to control the work flow of the computer, complete certain logical functions and achieve certain tasks. The algorithm is the logical abstraction of the program, which is the process of solving some objective problems. Data structure is a kind of mapping of data and its relations in the real world, the data structure can not only represent the physical structure of the data itself, but also can represent the logical structure in the computer.

To sum up, the relationship between data structure and algorithm, the two are both distinct and closely linked.

(3) Basic principles followed in data structure design

When solving a problem, how to design or select a data structure? Generally follow the following principles:

(1) Carefully analyze the problems to be solved, in particular, the data types and the logical relationships between the data in the problems.

(2) The preliminary design of data structure is usually carried out before the algorithm design.

(3) Pay attention to the extensibility of the data structure, include whether the data structure can adapt when the scale of input data changes. At the same time, the data structure should adapt to the evolution and expansion of problems.

(4) The design and selection of data structure also compare the advantages and disadvantages of the time and space cost of algorithm. The selection and evaluation of data structure is complex, and the factors that need to conedgered are not limited to the above, particular case is particular analysis.

DESIGN OF DATA STRUCTURE

The first premise of applying data structure to solve problems in life, which is to study the application of data structures to solve problems in life. The analysis steps as follows: first of all, analyze object operation in the task, find out data that involve task, summarize and abstract the operation object, and analyze the logical relationship among the operating objects; secondly, according to the operation of the operation object in the task, study what storage mode to store data can efficiently execute program and occupy less storage space. The selection of interface of the data structure must be closest to the software requirements. Usually when there are many data structures meet the demand, it can be selected according to the comparison of their running time of the interface operation and

consumption space of data structure, sometimes time and space can be converted to each other, such as the space can be used to exchange operating efficiency; finally, the correct algorithm is designed and the operation is realized based on the physical storage method, and complete the task.

The data to be processed in life can be abstracted from different logical relationships, set up different data structure, but the practical problem msut select the basic characteristics that can accurately describe the problem. For example, there is one coin is lighter in the eight coins, it is required to identify the light coin with a balance, the judgement process is to divide coins in two groups or three groups, Use the balance to compare the way to judge, respectively. This judgment process can be represented by a tree graph, so the problem can be abstracted into a decision tree and construct tree structure.

According to the selected data structure, different storage structures can be implemented. The common storage structures of different types of data structures are sequential storage structure, chain storage structure, hash storage structure and index storage structure. Different storage structures have different characteristics, and the difference exist in storage space and operation efficiency. For example, the sequential storage structure and the chain storage structure of the linear table are compared in the storage space, and the chain storage structure obviously occupy more storage space. Compared fom the computational efficiency, if the linear table requires a large number of insertions and deletions, then chain storage structure has an advantage in execution efficiency. If the linear table repeatedly carry out query operation, the sequential storage structure has the characteristics of random reading and writing, which is suitable for this situation.

APPLICATION EXAMPLES OF DATA STRUCTURE

In real life, as long as we observe carefully, we will find that there are also many examples of application data structures. For example: our family tree, genetic disease map, and company member position list all apply trees in the data structure. For another example, the navigation system and traffic light system in drive use the graph structure in the data structure. Therefore, the data structure is closely related to our lives, mastering the data structure is of far-reaching significance for us to effectively use computer program. The following takes graph as an example to analyze its application in reality.

Graph is a data structure that is more complex than a linear table or tree. Graph structure can describe all kinds of complicated data object, so the application of graph has penetrated into linguistics, logistics, physics, chemistry, telecommunication engineering, computer science and mathematics and so on.

There are four expression ways: adjacency matrix and adjacency list. The structure of various tables is suitable for sparse graphs.

There are two kinds of traversal modes in graph: depth-first traversal (like the preorder traversal of a tree), and breadth-first traversal (like tree's hierarchical traversal, queues are used). There are two methods of generating minimum spanning tree in graph: Prim Algorithm (two nodes set select the smallest edge to form collection, time complexity depends on the number of nodes), and Kruskal Algorithm (select from the smallest edge, until finally get a unified connected components, time complexity depends on the number of edges).

In many applications of graph, to solve the minimum spanning tree of network is a problem with significant practical significance. For example, establishing a communication network among n cities, n-1 communication lines need to be built. The n cities can be regarded as the n peak of the graph, the communication lines among each city are conedgered as edges, and the corresponding construction cost is the weight of the edge, thus forming a network. Because there are (n* (n-1)) /2 possible routes among n cities, if choose one of the n-1 lines (edge), construction costs are least. This is the problem to solve the minimum spanning tree problem for this network.

Graph theory also has the following application in daily life and study:

(1) Engineering application of directed acyclic graph:

Directed acyclic graph: its advantage is to represents a universal sub-expression, which can save a lot of storage space.

(2) How to check whether an undirected graph loop-free: whether the depth-first traversal has a back edge. The test has several connected components: the total number of calls to the depth-first traversal.

(3) Engineering application of directed acyclic graph:

Topological sort and partial order: part can be compared.

Total order: all can be compared.

Method of topological sorting: first remove the node with zero in-degree and its adjacent edge, and so on, until the end or remain one loop (the graph is not digraph).

Solve the critical path. Namely the longest path to directed acyclic graph, and it affects the most critical path of the entire project schedule.

It is believed that with the continuous development of data structure, graph theory will be more widely used in every field of real life.

CONCLUSION

In short, the data structure is the core of the computer and related professional courses, learning to analyze and study the characteristics of data structure of computer processing, selecting the appropriate logic structure, storage structure and algorithm for appled data, and these are the basis and guarantee which we can effectively use the computer to do program design.

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