

3. Basic notions concerning data structures: modeling, abstraction. Set, multiset, array, matrix.

1. What are modeling and abstraction?

Data structures are a fundamental concept in computer science and programming, and two important notions related to them are modeling and abstraction.

Modeling is the process of representing real-world objects or concepts in a computer program. In the context of data structures, modeling involves identifying the key characteristics of a data set or problem and designing a structure that can efficiently store, manipulate, and retrieve that data. For example, if we are working with a set of numbers, we might model them using an array or a linked list. If we are working with text, we might model it using a character array.

Abstraction, on the other hand, is the process of simplifying complex systems or data sets by focusing on the essential features and ignoring the details that are not relevant to the problem at hand. In the context of data structures, abstraction involves hiding the details of how the data is stored and manipulated behind a simple interface that provides the necessary functionality. For example, when working with a stack data structure, we don't need to know how the elements are stored internally; we only need to know that we can add elements to the top of the stack and remove them from the top.

By using modeling and abstraction, we can design data structures that are efficient, easy to use, and flexible enough to adapt to changing requirements. Good data structures are an essential building block of any software system and can make a big difference in the performance and maintainability of the code.

2. Some common set operations:

1. **Union:** The union of two sets A and B (written $A \cup B$) is the set of all elements that are in either A or B (or both). For example, if $A = \{1, 2, 3\}$ and $B = \{2, 4, 6\}$, then $A \cup B = \{1, 2, 3, 4, 6\}$.
2. **Intersection:** The intersection of two sets A and B (written $A \cap B$) is the set of all elements that are in both A and B. For example, if $A = \{1, 2, 3\}$ and $B = \{2, 4, 6\}$, then $A \cap B = \{2\}$.
3. **Difference:** The difference of two sets A and B (written $A \setminus B$) is the set of all elements that are in A but not in B. For example, if $A = \{1, 2, 3\}$ and $B = \{2, 4, 6\}$, then $A \setminus B = \{1, 3\}$.

3. What is multiset?

A multiset is a type of set that allows for repeated occurrences of its elements. In other words, it is a collection of objects where each object can appear more than once.

Multisets are often represented using a sequence of elements along with their multiplicities. For example, the multiset $S = \{1, 1, 2, 3\}$ contains two occurrences of the number 1, one occurrence of the number 2, and one occurrence of the number 3.

4. What is the 3 rows representation of a matrix?

The 3-row representation is a compact way of representing sparse matrices, and it is often used in computer programs to store and manipulate these matrices. It allows for efficient memory usage and easy indexing of the sparse matrix elements. However, it is important to note that the 3-row representation does not include any information about the dimensions or shape of the matrix, so it is important to keep track of this information separately.

5. Exercises for the representation and operation of sets.

Show the representations of sets A and B, and show the representations of $A \cup B$, $A \cap B$ and $A \setminus B$:

1. $A = \{3,7,4,6,1\}$, $B = \{2,9,5,6\}$, the elements in sets are between 1 and 9.
2. $A = \{B,E,A,F,G\}$, $B = \{C,F,G,B\}$, the elements in sets are between A and H.
3. $A = \{8,4,6,3\}$, $B = \{2,5,6,8\}$, the elements in sets are between 1 and 8.

6. Exercises for the representation and operation of multisets.

Show the representations of sets A and B, and show the representations of $A \cup B$, $A \cap B$ and $A \setminus B$:

1. $A = \{5,1,2,2,3,5,6,2\}$, $B = \{2,1,2,3,4,1,5,5\}$, the elements in sets are between 1 and 6.
2. $A = \{3,3,1,2,4,6,5,2\}$, $B = \{4,3,4,5,6,2,3,5\}$, the elements in sets are between 1 and 6.
3. $A = \{5,6,8,3,6,1,5,8\}$, $B = \{2,3,6,4,1,7,6,3\}$, the elements in sets are between 1 and 9.

7. Exercises for representation for matrices.

Show the row major order representation, the column major order representation and the 3 row representation of the following matrices.

1.

1	0	0	8
0	4	0	0
0	0	0	0
4	0	7	0

2.

0	0	0	1
1	0	9	0
0	0	0	0
0	3	2	0

3.

0	2	0	0	5
0	0	0	6	0
1	0	0	0	0
0	4	0	0	0
0	0	2	0	5