

Chapter 3

Linear Data Structures and Their Applications

Kavita Srivastava

Institute of Information Technology and Management, GGSIP University, India

ABSTRACT

In a linear data structure, the elements are arranged in a specific order. Each element on a linear data structure is connected to the elements that proceed it as well as the element that follows it. In other words, the elements are placed in sequential order. Hence, it is possible to traverse the elements in sequential order in a single pass. The objective of the chapter is to provide a basic understanding of linear data structures and their implementation in Python. The chapter is organized as follows. The chapter starts with an introduction to the linear data structure. The objective is to provide a basic understanding of linear data structures. A comparison of linear data structures and non-linear data structures is given next. Next, all of the above-mentioned data structures are explained in brief. The Python implementation of all of these data structures is provided. After that, their applications and their implementation in Python is discussed. The chapter concludes by highlighting the essential concepts.

INTRODUCTION

In the realm of data organization and efficient data processing, data structures play a vital role. They enable us to arrange and manage data effectively, allowing for the seamless execution of related operations. Data structures can be broadly categorized into Linear Data Structures and Non-Linear Data Structures. The linear arrangement facilitates sequential traversal in a single pass, distinguishing them from non-linear

DOI: 10.4018/978-1-6684-7100-5.ch003

systems. Common examples of linear data structures include arrays, linked lists, stacks, and queues (Domkin, 2021). Let's explore these data structures in detail, along with their applications.

Arrays

An array is a collection of elements identified by an index or a key. Details in an array are stored contiguously in memory, allowing random access. Furthermore, all elements in an array must belong to the same data type. Arrays find applications in various software systems that require storing similar records, such as employee management systems, library management systems, flight booking systems, and video rental applications (McKinney, 2010). They are also extensively used in image processing, where two-dimensional arrays represent image pixels.

Linked Lists

A linked list consists of interconnected nodes. Each node contains a data value and a pointer to the next node. Linked lists can be either singly linked or doubly linked. In a singly linked list, each node has a pointer to the next node, while in a doubly linked list, nodes have pointers to both the next and previous nodes, enabling bidirectional traversal. Circular linked lists, a variant of singly linked lists, have the last node pointing back to the first node. Linked lists are employed when storing records in non-contiguous memory locations and when dynamic memory allocation is required (Boockmann & Lüttgen, 2020). Applications of linked lists include web page navigation through hyperlinks, organization of social media content and feeds, symbol table management in IDEs and compilers, multiplayer games, and the implementation of various operating system algorithms.

Stacks

A stack follows the Last-In-First-Out (LIFO) principle, where elements are added and removed from the top of the Stack. The `push()` operation adds an element to the top, while the `pop()` function removes the topmost element. Stacks find numerous applications, such as evaluating postfix expressions, maintaining history and logs, creating playlists, and implementing recursion (Buckley & Buckley, 2017).

Queues

A queue operates on the First-In-First-Out (FIFO) principle, where elements are added at the back and removed from the front. The primary application of queues

22 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/linear-data-structures-and-their-applications/326078

Related Content

Organizing Data Using Lists: A Sequential Data Structure

Saleem Raja Abdul Samad, N. Arulkumar, Justin Rajasekaran, R. Vinodiniand Pradeepa Ganesan (2023). *Advanced Applications of Python Data Structures and Algorithms* (pp. 35-51).

www.irma-international.org/chapter/organizing-data-using-lists/326077

Exception Handling

(2023). *Principles, Policies, and Applications of Kotlin Programming* (pp. 100-115).

www.irma-international.org/chapter/exception-handling/323933

Exploring the Scikit-Learn Package With ChatGPT

Kadir Uludag (2024). *The Pioneering Applications of Generative AI* (pp. 251-273).

www.irma-international.org/chapter/exploring-the-scikit-learn-package-with-chatgpt/350787

Pointers

(2024). *Advancements, Applications, and Foundations of C++* (pp. 217-255).

www.irma-international.org/chapter/pointers/345783

Graphics

(2025). *ODE, BVP, and 1D PDE Solvers for Scientific and Engineering Problems With MATLAB Basics* (pp. 72-111).

www.irma-international.org/chapter/graphics/369595