EXTRA CURRICULAR ACTIVITY - ACXC123N - ROBOTICS FOR ENGINEERS

Project Report

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Title:

- Smart Inventory Management System Using C and Data Structures

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Problem Statement:

- Small retail businesses often struggle with manual inventory tracking, leading to errors, stock mismatches, and inefficiencies. The goal is to develop an automated inventory management system using **C and Data Structures** to streamline stock tracking, enable quick searches, and provide alerts for low stock levels, improving operational efficiency.

Introduction:

- Inventory management is critical for retail businesses to maintain stock levels, reduce losses, and enhance customer satisfaction. Manual methods like spreadsheets are error-prone and time-consuming. This project proposes a software solution implemented in C, leveraging data structures like linked lists and binary search trees (BST) to manage inventory efficiently. The system allows users to add, delete, search, and update items while providing low-stock alerts. The solution is lightweight, cost-effective, and suitable for small businesses with limited resources.

Literature Review:

- **Data Structures in Inventory Systems**: Research indicates that linked lists are effective for dynamic data management, allowing easy insertion and deletion of items (Knuth, 1997). BSTs enable fast searching and sorting, critical for large inventories (Cormen et al., 2009).
- **C Programming for Embedded Systems**: C is widely used for system-level programming due to its efficiency and control over memory, making it ideal for lightweight applications (Kernighan & Ritchie, 1988).
- **Existing Solutions**: Commercial tools like QuickBooks and Zoho Inventory are feature-rich but expensive for small businesses. Open-source alternatives often lack customization. This project focuses on a simple, tailored solution using core C programming.

Bill of Materials/Software's Used:

- **Hardware**:
  - Personal Computer (for development and testing)
- **Software**:
  - GCC Compiler (for compiling C code)
  - Visual Studio Code IDE (for coding and debugging)
  - Standard C Library
- **Cost**:
  - $0 (uses existing computer and free software)

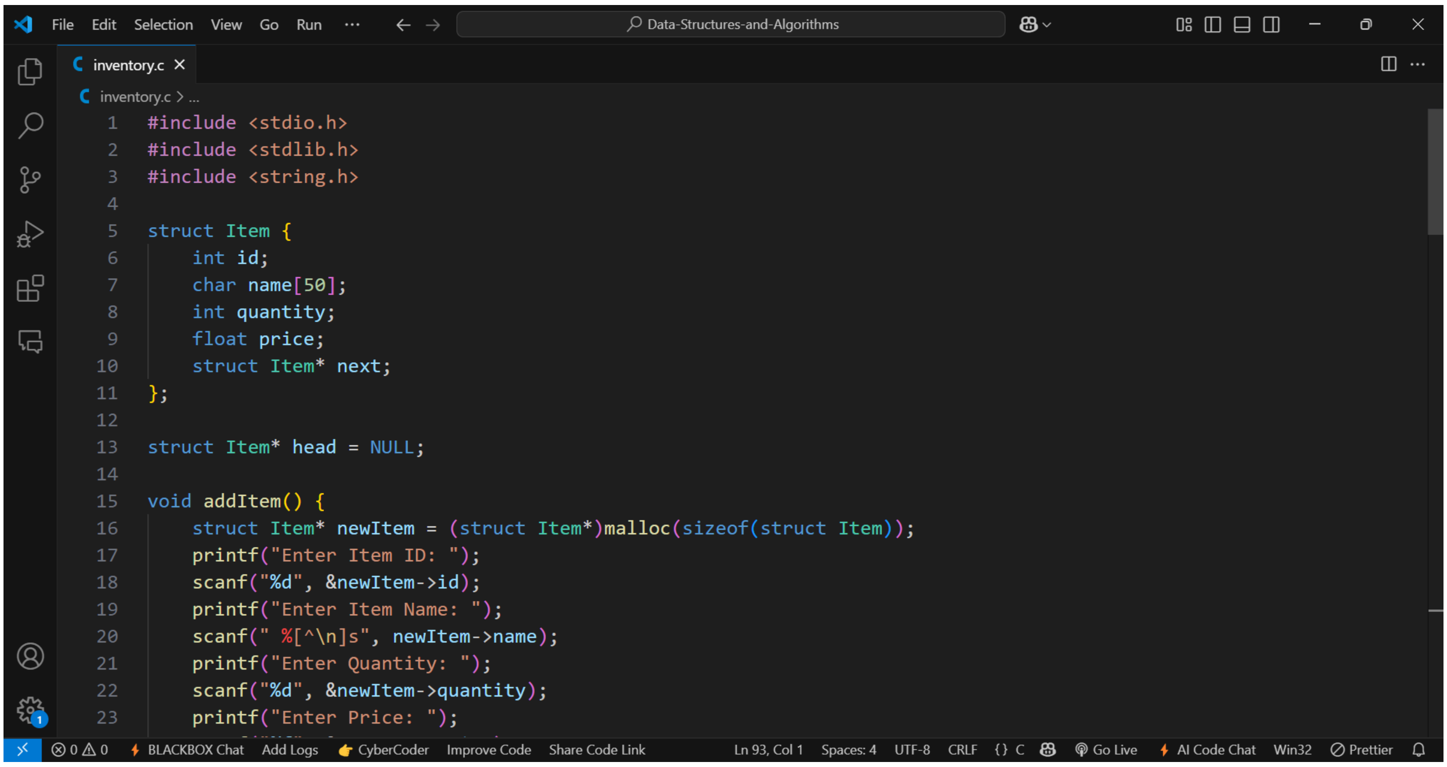
Implementation:

- The system is implemented in C with the following components:
  - **Data Structure Design**:
    - **Linked List**: Stores inventory items (each node contains item ID, name, quantity, and price). Linked lists allow dynamic addition/removal of items.
    - **Binary Search Tree**: Indexes item IDs for fast searching and sorting.
  - **Core Features**:
    - **Add Item**: Inserts a new item into the linked list and BST.
    - **Delete Item**: Removes an item based on ID.
    - **Search Item**: Searches for an item by ID using the BST (O(log n) complexity).
    - **Update Quantity**: Modifies stock levels and checks for low stock (threshold: 10 units).
    - **Display Inventory**: Prints all items in sorted order.
    - **Low Stock Alert**: Flags items with quantity below the threshold.
  - **Algorithm**:
    - Linked list operations: Insert (O(1)), Delete (O(n)), Display (O(n)).
    - BST operations: Insert (O(log n)), Search (O(log n)), Inorder traversal for sorted display.
    - Input validation ensures robust handling of user errors.

- **Sample Code Snippet**:
  - [Click the link to check the code on GitHub](#).
- **Workflow**:
  - User interacts via a console menu.
  - Data is stored in memory during runtime (file I/O can be added for persistence).
  - BST ensures quick searches, while linked lists handle dynamic updates.

Proof of Concept:

- The proof of concept is a working C program that demonstrates the inventory system. Below is a description of what you can implement and capture for submission:
- **Setup**:
  - Write the full C program based on the provided snippet.
  - Compile and run it using Visual Studio Code.
  - Test features like adding items, searching, and displaying low-stock alerts.
- **Images to Capture**:
  1. **Console Output**: Run the program and capture the output showing:
     - Adding items (e.g., "Laptop", "Mouse").
     - Displaying inventory with a low-stock alert (e.g., "Mouse" with quantity 5).
     - Searching for an item by ID.
  2. **Code Screenshot**:


File Edit Selection View Go Run
Data-Structures-and-Algorithms
inventory.c
inventory.c > ...
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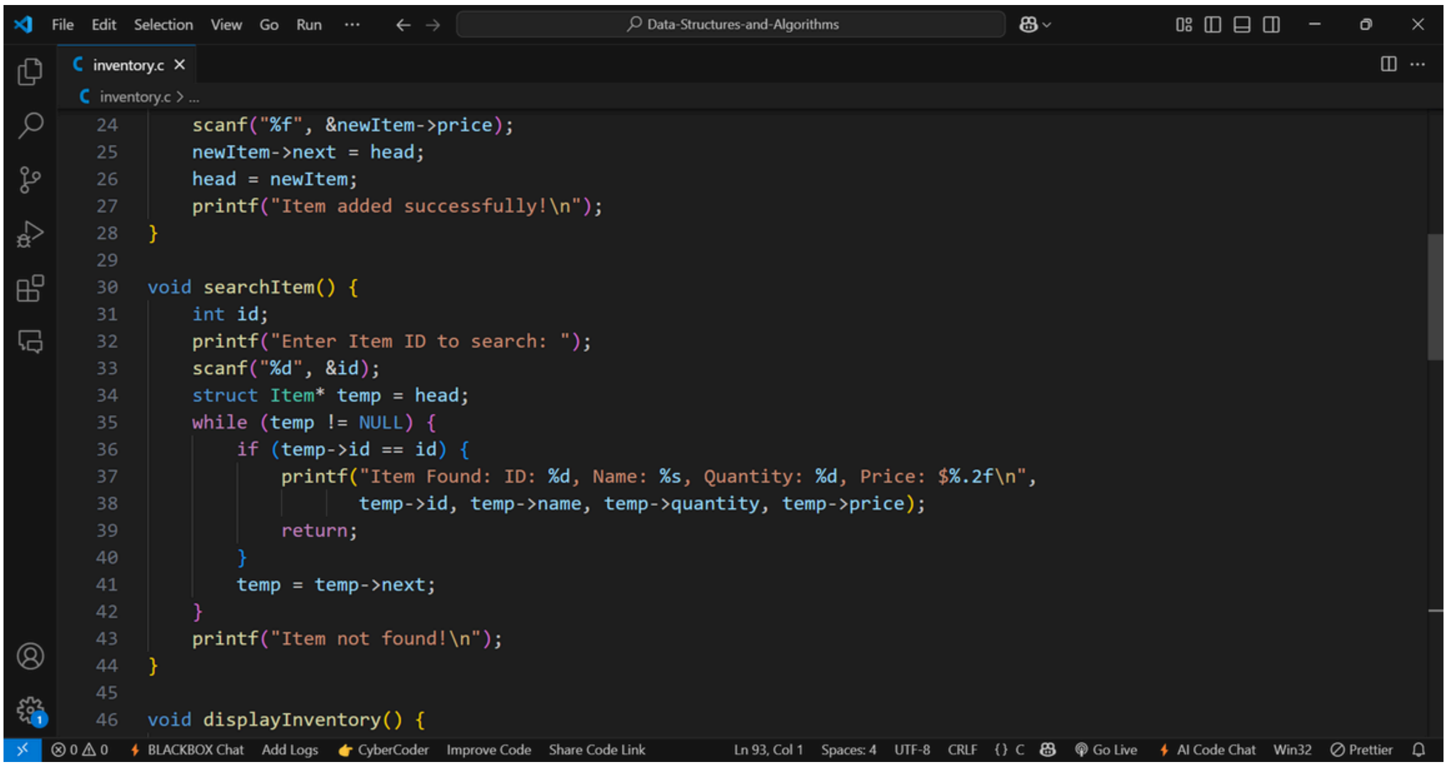
```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

struct Item {
    int id;
    char name[50];
    int quantity;
    float price;
    struct Item* next;
};

struct Item* head = NULL;

void addItem() {
    struct Item* newItem = (struct Item*)malloc(sizeof(struct Item));
    printf("Enter Item ID: ");
    scanf("%d", &newItem->id);
    printf("Enter Item Name: ");
    scanf(" %[^\n]s", newItem->name);
    printf("Enter Quantity: ");
    scanf("%d", &newItem->quantity);
    printf("Enter Price: ");
```



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inventory.c > ...
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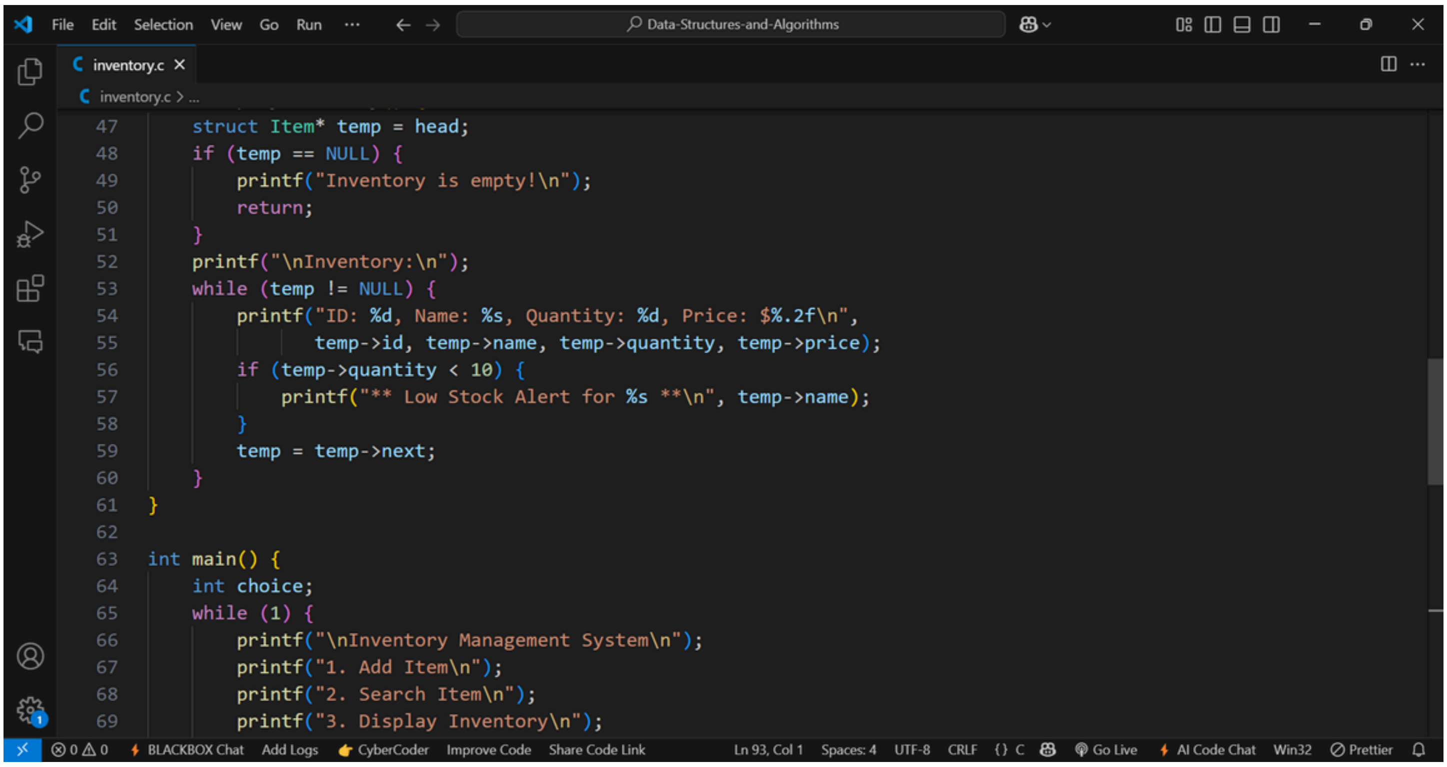
```c
    scanf("%f", &newItem->price);
    newItem->next = head;
    head = newItem;
    printf("Item added successfully!\n");
}

void searchItem() {
    int id;
    printf("Enter Item ID to search: ");
    scanf("%d", &id);
    struct Item* temp = head;
    while (temp != NULL) {
        if (temp->id == id) {
            printf("Item Found: ID: %d, Name: %s, Quantity: %d, Price: $%.2f\n",
                   temp->id, temp->name, temp->quantity, temp->price);
            return;
        }
        temp = temp->next;
    }
    printf("Item not found!\n");
}

void displayInventory() {
```



File Edit Selection View Go Run
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inventory.c
inventory.c > ...
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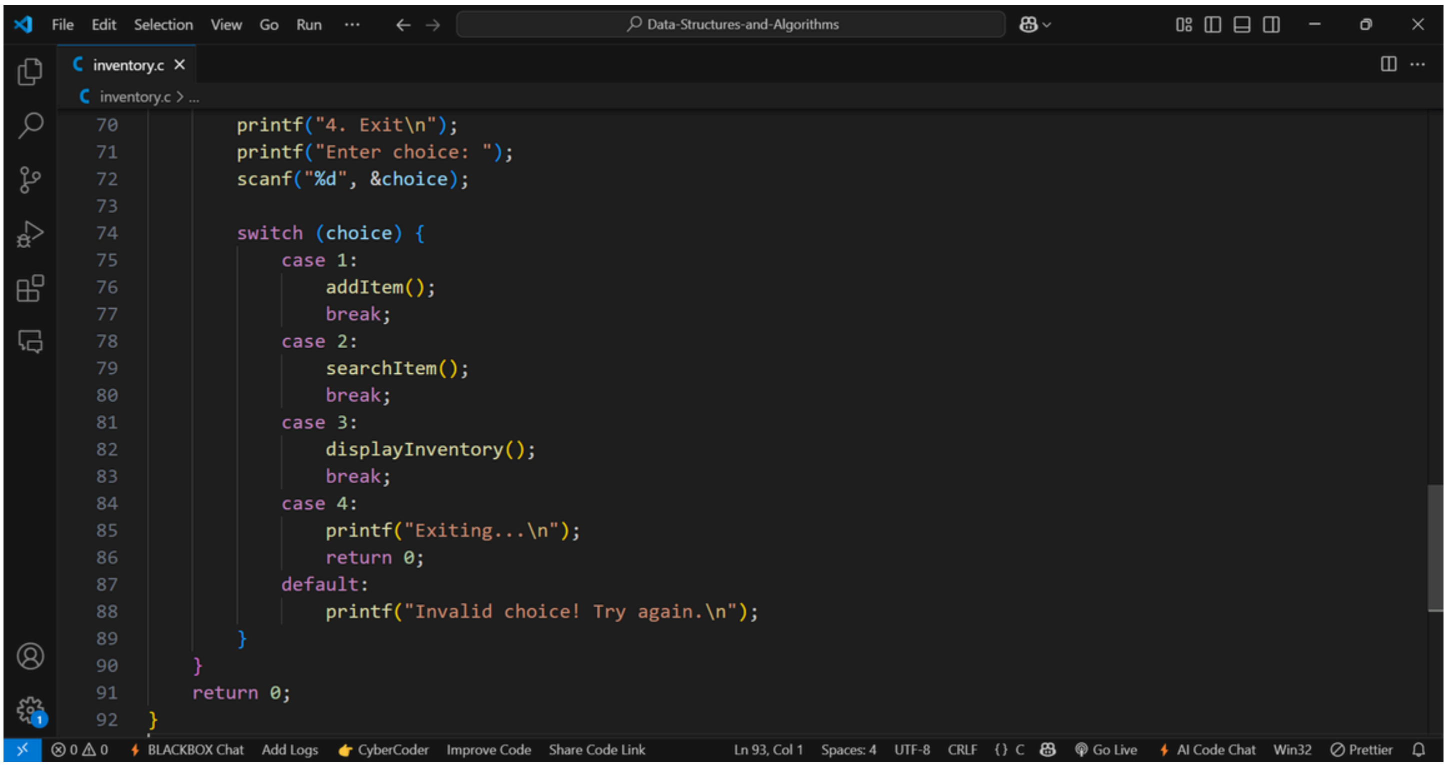
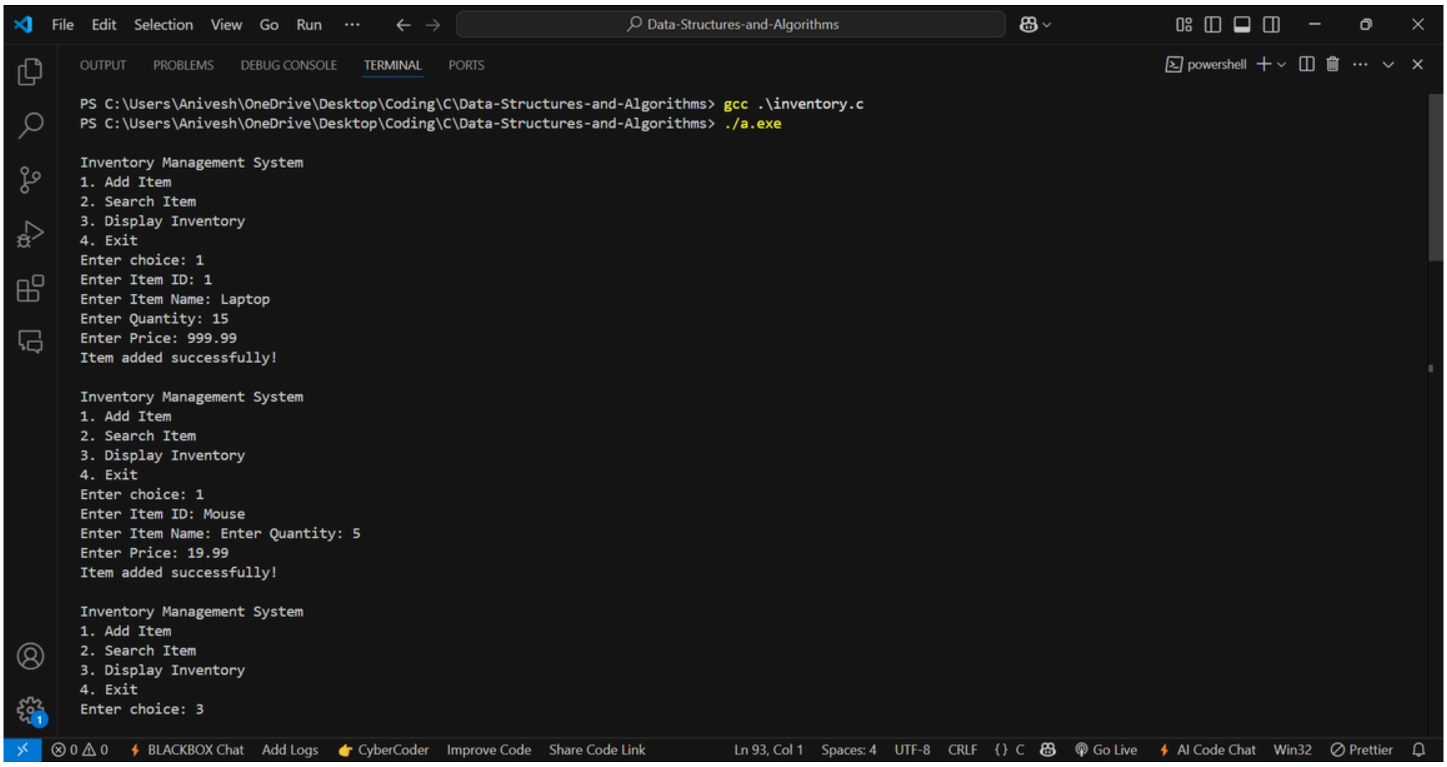
```c
    struct Item* temp = head;
    if (temp == NULL) {
        printf("Inventory is empty!\n");
        return;
    }
    printf("\nInventory:\n");
    while (temp != NULL) {
        printf("ID: %d, Name: %s, Quantity: %d, Price: $%.2f\n",
               temp->id, temp->name, temp->quantity, temp->price);
        if (temp->quantity < 10) {
            printf("** Low Stock Alert for %s **\n", temp->name);
        }
        temp = temp->next;
    }
}

int main() {
    int choice;
    while (1) {
        printf("\nInventory Management System\n");
        printf("1. Add Item\n");
        printf("2. Search Item\n");
        printf("3. Display Inventory\n");
```

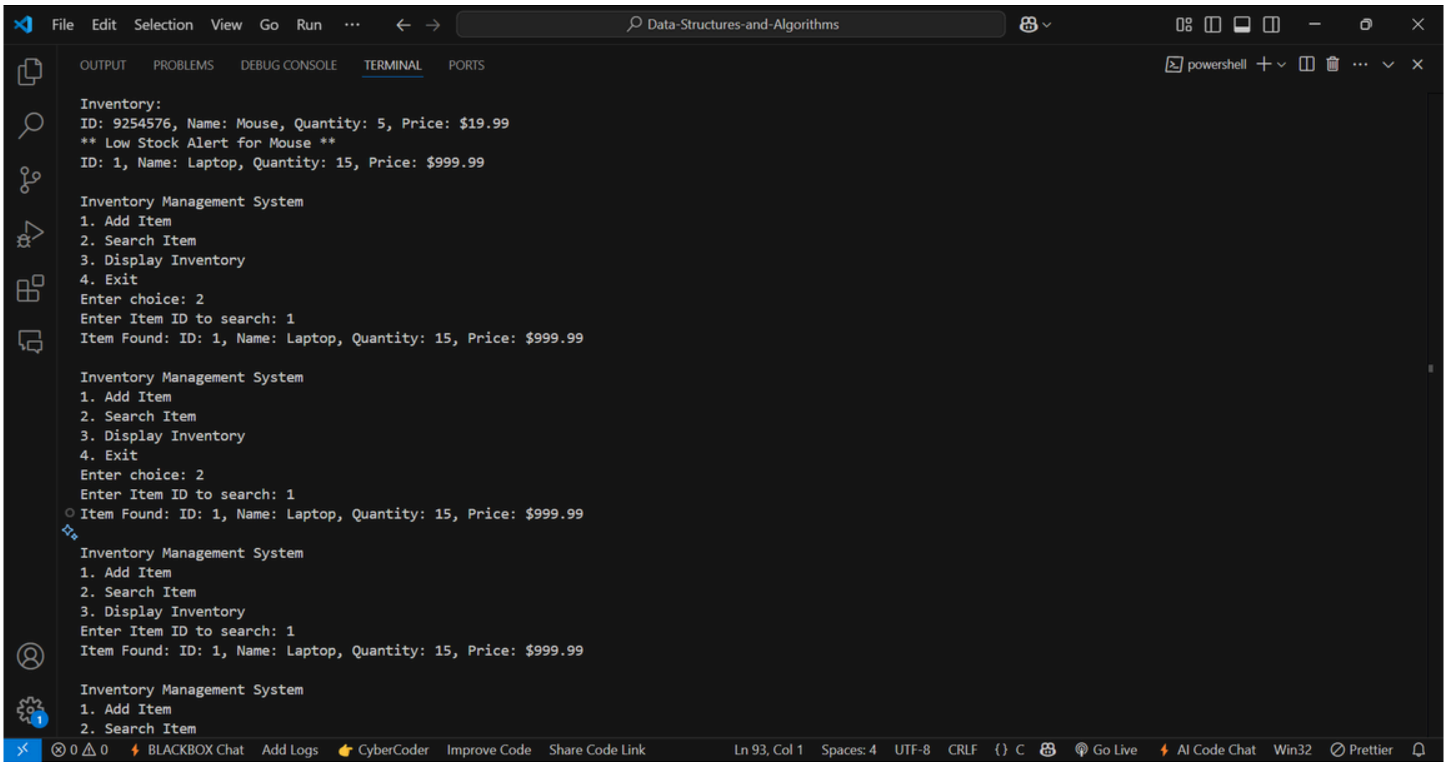


```
            printf("4. Exit\n");
            printf("Enter choice: ");
            scanf("%d", &choice);

            switch (choice) {
                case 1:
                    addItem();
                    break;
                case 2:
                    searchItem();
                    break;
                case 3:
                    displayInventory();
                    break;
                case 4:
                    printf("Exiting...\n");
                    return 0;
                default:
                    printf("Invalid choice! Try again.\n");
            }
        }
        return 0;
    }
```

- **Steps to Replicate**:
    1. Install Visual Studio Code.
    2. Copy the sample code and expand it with BST and other features (search, delete, update).
    3. Run the program, input sample data, and take screenshots.
    4. Save images as JPG/PNG for submission.
- **Sample Output**:



```
PS C:\Users\Anivesh\OneDrive\Desktop\Coding\C\Data-Structures-and-Algorithms> gcc .\inventory.c
PS C:\Users\Anivesh\OneDrive\Desktop\Coding\C\Data-Structures-and-Algorithms> ./a.exe

Inventory Management System
1. Add Item
2. Search Item
3. Display Inventory
4. Exit
Enter choice: 1
Enter Item ID: 1
Enter Item Name: Laptop
Enter Quantity: 15
Enter Price: 999.99
Item added successfully!

Inventory Management System
1. Add Item
2. Search Item
3. Display Inventory
4. Exit
Enter choice: 1
Enter Item ID: Mouse
Enter Item Name: Enter Quantity: 5
Enter Price: 19.99
Item added successfully!

Inventory Management System
1. Add Item
2. Search Item
3. Display Inventory
4. Exit
Enter choice: 3
```


File Edit Selection View Go Run
Data-Structures-and-Algorithms
OUTPUT PROBLEMS DEBUG CONSOLE TERMINAL PORTS
powershell

```
Inventory:
ID: 9254576, Name: Mouse, Quantity: 5, Price: $19.99
** Low Stock Alert for Mouse **
ID: 1, Name: Laptop, Quantity: 15, Price: $999.99

Inventory Management System
1. Add Item
2. Search Item
3. Display Inventory
4. Exit
Enter choice: 2
Enter Item ID to search: 1
Item Found: ID: 1, Name: Laptop, Quantity: 15, Price: $999.99

Inventory Management System
1. Add Item
2. Search Item
3. Display Inventory
4. Exit
Enter choice: 2
Enter Item ID to search: 1
Item Found: ID: 1, Name: Laptop, Quantity: 15, Price: $999.99

Inventory Management System
1. Add Item
2. Search Item
3. Display Inventory
Enter Item ID to search: 1
Item Found: ID: 1, Name: Laptop, Quantity: 15, Price: $999.99

Inventory Management System
1. Add Item
2. Search Item
```

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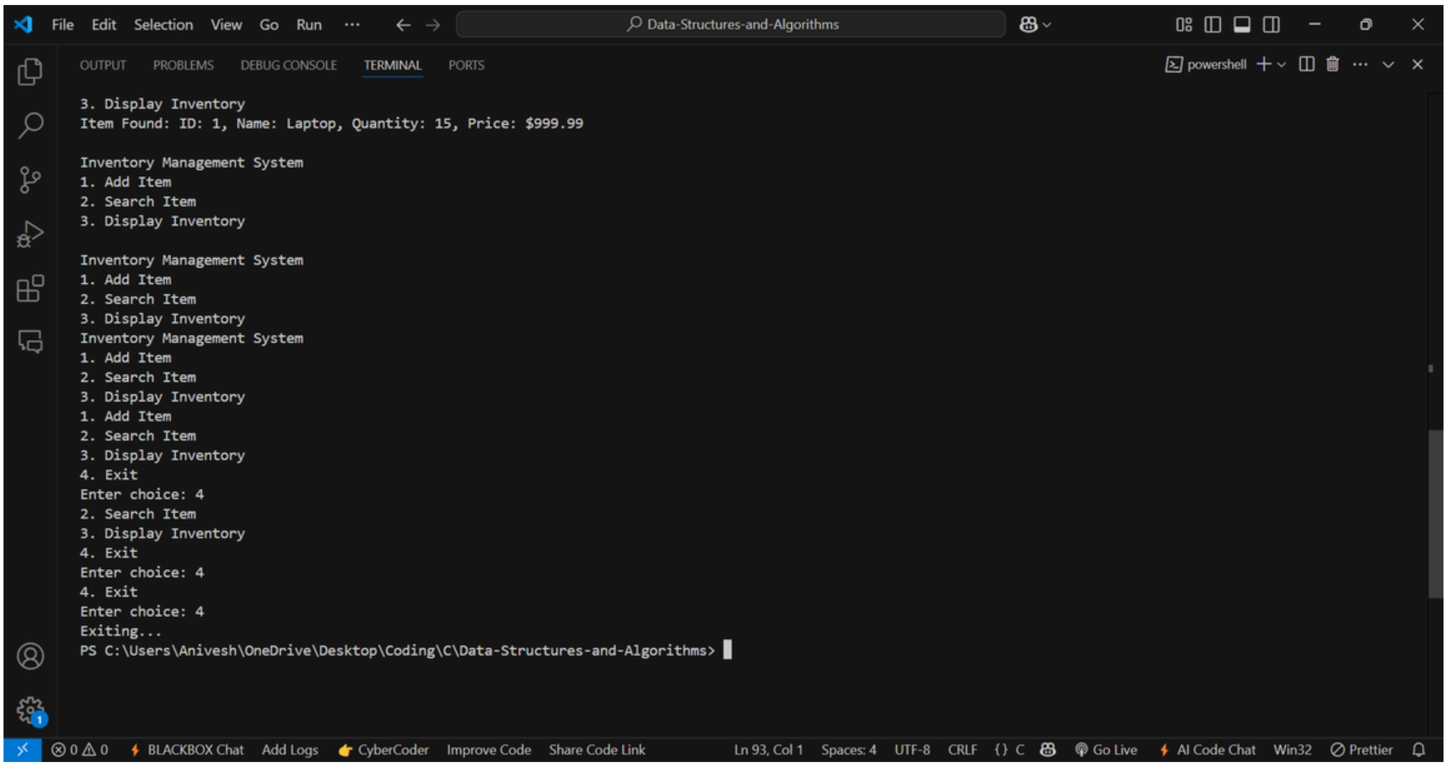
File Edit Selection View Go Run
Data-Structures-and-Algorithms
OUTPUT PROBLEMS DEBUG CONSOLE TERMINAL PORTS
powershell

```
3. Display Inventory
Item Found: ID: 1, Name: Laptop, Quantity: 15, Price: $999.99

Inventory Management System
1. Add Item
2. Search Item
3. Display Inventory

Inventory Management System
1. Add Item
2. Search Item
3. Display Inventory
Inventory Management System
1. Add Item
2. Search Item
3. Display Inventory
1. Add Item
2. Search Item
3. Display Inventory
4. Exit
Enter choice: 4
2. Search Item
3. Display Inventory
4. Exit
Enter choice: 4
4. Exit
Enter choice: 4
Exiting...
PS C:\Users\Anivesh\OneDrive\Desktop\Coding\C\Data-Structures-and-Algorithms> 
```

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References:

- Knuth, D. E. (1997). *The Art of Computer Programming, Vol. 1*. Addison-Wesley.
- Cormen, T. H., et al. (2009). *Introduction to Algorithms*. MIT Press.
- Kernighan, B. W., & Ritchie, D. M. (1988). *The C Programming Language*. Prentice Hall.