

Inventory Track Pro: Smart Inventory Management System

Data Structures and Algorithms Project Report

Project Title: Inventory Track Pro: Smart Inventory Management System

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Course: Data Structures and Algorithms Lab

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1.0 Introduction

Inventory Track Pro is a console-based inventory management system that implements core DSA concepts for efficient product management. The system combines multiple data structures to provide fast operations, dynamic sorting, and data persistence.

Objectives:

- Demonstrate practical application of DSA concepts
- Provide efficient inventory management operations
- Implement robust error handling and data validation
- Enable data persistence through file I/O

2.1 Data Structures Used

Data Structure	Purpose	Key Operations
Hash Table	Primary storage	O(1) search/insert/delete
Binary Search Tree	Range queries	O(log n) price range search
Arrays	Sorting operations	Merge Sort & Quick Sort
Stacks	Undo/Redo	Action history tracking
File I/O	Data persistence	Save/load inventory

3.0 Key Features

3.1 Product Management

- **Add Product:** Validates and stores new products
- **Search Product:** Fast lookup using hash table
- **Update Product:** Modify existing product details
- **Delete Product:** Remove products with confirmation

3.2 Advanced Operations

- **Sorting:** By price, rating, or sales (ascending/descending)
- **Range Search:** Find products within price range
- **Undo/Redo:** Revert/redo last operations
- **File Operations:** Save/load from CSV files

3.3 Error Handling

- Input validation for all data types
- Range checking for numerical values
- File error handling and recovery
- User-friendly error messages

4.0 Implementation Details

4.1 Data Structures

```
struct Product {  
    string id, name, category;  
    double price, rating;  
    int stock, sales;  
};  
  
struct HashNode {  
    Product product;  
    HashNode* next;  
};  
  
struct BSTNode {  
    Product product;  
    BSTNode* left, *right;  
};
```

4.2 Key Algorithms

Hash Function:

```
int hashFunction(string id) {  
    int hash = 0;  
    for (int i = 0; i < id.length(); i++) {  
        hash = hash * 31 + id[i];  
    }  
    return abs(hash) % 100;  
}
```

Sorting Algorithms:

- **Merge Sort:** Stable, $O(n \log n)$
- **Quick Sort:** In-place, $O(n \log n)$ average

Range Search: Modified BST in-order traversal

5.0 Performance Analysis

5.1 Time Complexity

Operation	Average Case	Worst Case
Add/Search/Delete	$O(1)$	$O(n)$
Update	$O(1)$	$O(n)$
Range Search	$O(\log n + k)$	$O(n)$
Sorting	$O(n \log n)$	$O(n \log n)$
Undo/Redo	$O(1)$	$O(1)$

5.2 Space Complexity

- Hash Table: $O(n)$
- BST: $O(n)$
- Arrays: $O(n)$ temporary
- Stacks: $O(m)$ operations
- **Total:** $O(n)$ linear

6.0 Testing Results

6.1 Functional Testing

- ✓ Add product with validation
- ✓ Search existing/non-existent products
- ✓ Update product information
- ✓ Delete with confirmation
- ✓ Sort by all criteria
- ✓ Range search functionality
- ✓ Undo/redo operations
- ✓ File save/load operations

6.2 Error Testing

- ✓ Invalid input handling
- ✓ Out-of-range values
- ✓ Duplicate ID prevention
- ✓ File error recovery
- ✓ Memory management

7.0 User Interface

Main Menu Interface

```
PS D:\University\DSA_LAB\project_DSA> cd "d:\University\DSA_LAB\project_DSA\" ;  
ct }  
  
=====
```

INVENTORY TRACK PRO - DSA PROJECT

```
=====
```

=== INVENTORY TRACK PRO ===

1. Add Product
2. Search Product
3. Update Product
4. Delete Product
5. Display All Products
6. Sort Products
7. Range Search by Price
8. Undo Last Operation
9. Redo Last Operation
10. Save to File
11. Load from File
12. Exit

```
=====
```

Enter your choice (1-12): 1

=== ADD NEW PRODUCT ===

Enter Product ID: 001

Enter Product Name: Laptop

Enter Category: Electronic

Enter Price: \$200

Enter Rating (0-5): 4

Enter Stock: 10

Enter Sales: 4

Product added successfully!

=====

Enter your choice (1-12): 5

=== ALL PRODUCTS ===

ID	Name	Category	Price	Rating	Stock	Sales
001	Laptop	Electronic	\$200.00	4.0	10	4

Total Products: 1

Random Data Added :

001,Wireless Headphones,Electronics,129.99,4.3,45,300

002,Blender,Kitchen Appliances,79.99,4.1,23,187

003,Yoga Mat,Fitness,34.50,4.7,82,415

004,Coffee Maker,Home Appliances,89.99,4.5,18,256

005,Running Shoes,Sports,119.99,4.2,67,522

006,Desk Lamp,Home Decor,42.75,4.4,52,198

007,Leather Wallet,Fashion,29.99,4.8,124,743

008,Board Game,Entertainment,49.99,4.6,36,89

009,Backpack,Travel,64.99,4.0,41,210

010,Plant Pot,Garden,24.50,4.9,88,331

=====

Enter your choice (1-12): 5

=== ALL PRODUCTS ===

ID	Name	Category	Price	Rating	Stock	Sales
001	Wireless Headphones	Electronics	\$129.99	4.3	45	300
002	Blender	Kitchen Appliances	\$79.99	4.1	23	187
003	Yoga Mat	Fitness	\$34.50	4.7	82	415
004	Coffee Maker	Home Appliances	\$89.99	4.5	18	256
005	Running Shoes	Sports	\$119.99	4.2	67	522
006	Desk Lamp	Home Decor	\$42.75	4.4	52	198
007	Leather Wallet	Fashion	\$29.99	4.8	124	743
008	Board Game	Entertainment	\$49.99	4.6	36	89
009	Backpack	Travel	\$64.99	4.0	41	210
010	Plant Pot	Garden	\$24.50	4.9	88	331

Total Products: 10

Search Operation Results:

```

=====
Enter your choice (1-12): 2

=== SEARCH PRODUCT ===
Enter Product ID to search: 004

Product Found:
ID: 004
Name: Coffee Maker
Category: Home Appliances
Price: $89.99
Rating: 4.5
Stock: 18
Sales: 256

```

Sorting Products by Price:

```

=====
Enter your choice (1-12): 6

=== SORT PRODUCTS ===

=== SORT OPTIONS ===
Sort by:
1. Price
2. Rating
3. Sales
Enter your choice (1-3): 1

=== SORTING ALGORITHM ===
1. Merge Sort
2. Quick Sort
Enter your choice (1-2): 1

=== SORT ORDER ===
1. Ascending
2. Descending
Enter your choice (1-2): 1

Sorted using Merge Sort:

```

ID	Name	Price	Rating	Stock	Sales
010	Plant Pot	\$24.50	4.9	88	331
007	Leather Wallet	\$29.99	4.8	124	743
003	Yoga Mat	\$34.50	4.7	82	415
006	Desk Lamp	\$42.75	4.4	52	198
008	Board Game	\$49.99	4.6	36	89
009	Backpack	\$64.99	4.0	41	210
002	Blender	\$79.99	4.1	23	187
004	Coffee Maker	\$89.99	4.5	18	256
005	Running Shoes	\$119.99	4.2	67	522
001	Wireless Headphones	\$129.99	4.3	45	300

Range Search Results

```

=====
Enter your choice (1-12): 7

=== RANGE SEARCH BY PRICE ===
Enter minimum price: $24
Enter maximum price: $40

=== PRODUCTS IN PRICE RANGE $24.0 to $40.0 ===
ID: 010 Name: Plant Pot Price: $24.5
ID: 007 Name: Leather Wallet Price: $30.0
ID: 003 Name: Yoga Mat Price: $34.5

```

Undo Operation Demonstration: Deleting 001 product and Undoing it.

```

=====
Enter your choice (1-12): 4

=== DELETE PRODUCT ===
Enter Product ID to delete: 001
Are you sure you want to delete product '001'? (y/n): y
Product deleted successfully!

```

```

=====
Enter your choice (1-12): 5

=== ALL PRODUCTS ===

```

ID	Name	Category	Price	Rating	Stock	Sales
002	Blender	Kitchen Appliances	\$79.99	4.1	23	187
003	Yoga Mat	Fitness	\$34.50	4.7	82	415
004	Coffee Maker	Home Appliances	\$89.99	4.5	18	256
005	Running Shoes	Sports	\$119.99	4.2	67	522
006	Desk Lamp	Home Decor	\$42.75	4.4	52	198
007	Leather Wallet	Fashion	\$29.99	4.8	124	743
008	Board Game	Entertainment	\$49.99	4.6	36	89
009	Backpack	Travel	\$64.99	4.0	41	210
010	Plant Pot	Garden	\$24.50	4.9	88	331

```

-----
Total Products: 9

```

```

=====
Enter your choice (1-12): 8
Product added successfully!
Undo operation completed!

```



```
=====
Enter your choice (1-12): 5

=== ALL PRODUCTS ===
ID      Name                Category      Price      Rating  Stock  Sales
-----
001     Wireless Headphones     Electronics   $129.99    4.3     45     300
002     Blender                  Kitchen Appliances $79.99    4.1     23     187
003     Yoga Mat                 Fitness       $34.50    4.7     82     415
004     Coffee Maker             Home Appliances $89.99    4.5     18     256
005     Running Shoes            Sports        $119.99   4.2     67     522
006     Desk Lamp                Home Decor    $42.75    4.4     52     198
007     Leather Wallet           Fashion       $29.99    4.8     124    743
008     Board Game               Entertainment $49.99    4.6     36     89
009     Backpack                 Travel        $64.99    4.0     41     210
010     Plant Pot                Garden        $24.50    4.9     88     331
-----
Total Products: 10
```

File Save Operation

```
=====
Enter your choice (1-12): 10

=== SAVE TO FILE ===
Enter filename to save (e.g., products.txt): ProductData.txt
Successfully saved 10 products to ProductData.txt
```

8.0 Advantages

- 1. **Efficiency:** O(1) operations using hash table
- 2. **Flexibility:** Multiple sorting options
- 3. **Reliability:** Comprehensive error handling
- 4. **Usability:** Undo/redo functionality
- 5. **Persistence:** File-based data storage
- 6. **Scalability:** Handles up to 1000 products

9.0 Limitations & Future Work

9.1 Current Limitations

- Fixed hash table size (100 buckets)
- BST can degrade with sorted input
- Console-based interface only

- Single-criterion sorting

9.2 Future Enhancements

1. **Data Structures:** Dynamic hash table, AVL tree
2. **Features:** Multi-field search, statistics
3. **Interface:** Graphical user interface
4. **Performance:** Caching, indexing
5. **Advanced:** Network support, APIs

10.0 Conclusion

Inventory Track Pro successfully demonstrates practical implementation of DSA concepts in inventory management. The system provides efficient operations through hybrid data structure usage while maintaining robustness through comprehensive error handling.

Key Achievements:

- Practical application of hash tables, BST, sorting algorithms
- Efficient product management operations
- User-friendly interface with error recovery
- Complete data persistence solution

The project serves as an excellent foundation for more advanced inventory systems and demonstrates the importance of appropriate data structure selection for specific operations.