**Exercise 1: Inventory Management System**

**1. Understand the Problem:**

* **Importance of Data Structures and Algorithms:**
  + Data structures help organize and manage large volumes of inventory items efficiently.
  + Efficient algorithms ensure quick search, insert, update, and delete operations.
  + Without optimized structures, managing thousands of products would lead to performance issues and data retrieval delays.
* **Suitable Data Structures:**
  + **HashMap (Dictionary):** Ideal for storing product information with product IDs as keys for fast access.
  + **ArrayList or LinkedList:** Useful for maintaining ordered lists but slower for search and deletion.
  + **TreeMap:** Maintains sorted order of keys and allows logarithmic time operations.
  + **Set:** Helpful for tracking unique identifiers or categories.

**4. Analysis:**

* **Time Complexity of Operations in HashMap:**
  + **Add (Insertion):** Average case O(1), Worst case O(n) if there are many collisions.
  + **Update:** Average case O(1), since key lookup is direct.
  + **Delete:** Average case O(1), Worst case O(n) in case of poor hash function performance.
* **Optimization Techniques:**
  + Use a good hash function to reduce collisions and maintain constant-time operations.
  + Load factor should be maintained below the threshold (commonly 0.75) to avoid rehashing overhead.
  + Use separate chaining or open addressing for efficient collision resolution.
  + If sorted data is needed, consider using TreeMap instead of HashMap for O(log n) operations with ordering.