

CSCI 5408
DATA MANAGEMENT AND
WAREHOUSING

ASSIGNMENT – 1

Problem 2: Documentation of Design Principle

Banner ID: B00948977

Git Assignment Link:

https://git.cs.dal.ca/sukumaran/csci5408_f23_b00948977_balaji_sukumaran/-/tree/main/Assignment1

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Section 1: Project folder structure

The custom database management system application has been built by adapting a **layered architecture**, where the entire codebase has been abstracted and split into the following layers:

- **Application layer:** Contains the code that will be used by the end-user.
- **Business service layer (service):** All the business logic code will be placed in this package.
- **Data access layer (data):** Data access-related code will be placed in this package.
- **Common:** Contains helpers and constants used throughout the entire codebase.

In a layered architecture pattern [1], components are structured in horizontal tiers, with each layer being self-contained and independent from the others. This conventional approach to software design ensures that while components are interconnected, they do not rely on each other for functionality.

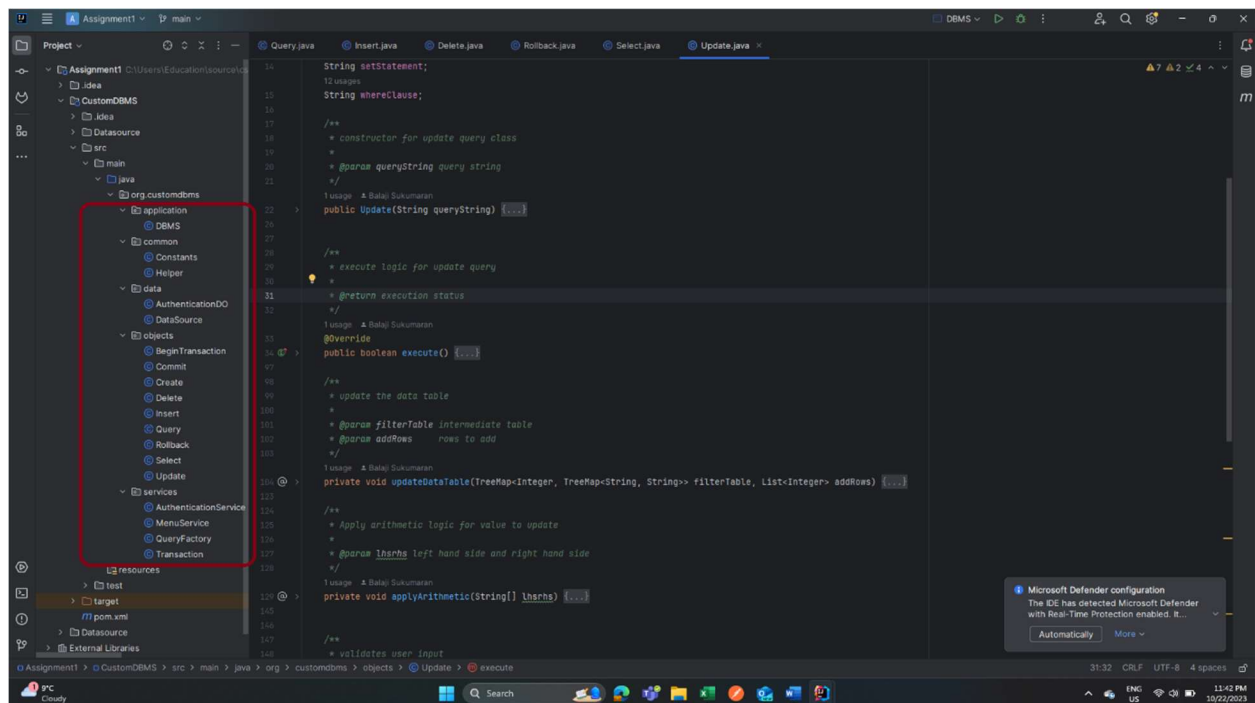


Figure 1: Folder structure for the custom database management system

Section 2: Factory design pattern for implementing different query types.

The factory method is a design pattern that offers an interface or an abstract class to create an object, giving the responsibility to its subclasses to determine the class to instantiate. This pattern falls under the category of creational patterns [2].

Based on the query string provided by the user, the QueryFactory assigns the appropriate object in the control flow, along with its corresponding implementation of the execute method.

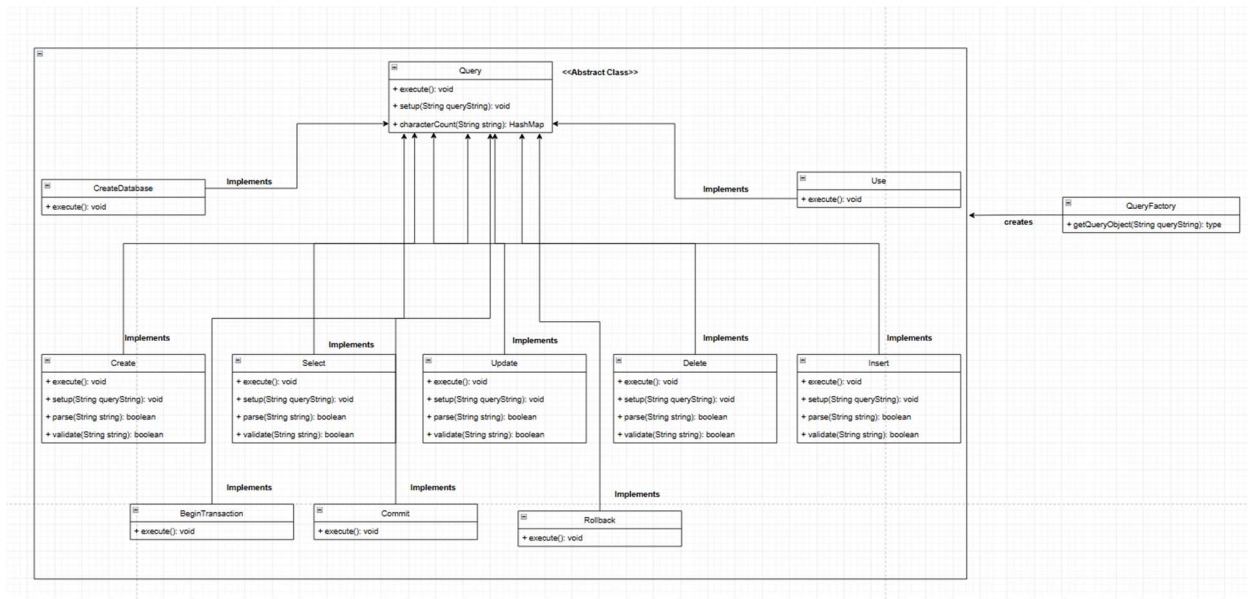


Figure 2: Factory design pattern in custom database management system

```
package org.customdms.services;
import org.customdms.objects.*;
import java.util.ArrayList;

/**
 * Query factory class
 */
// @author: A. Sakshi Subramanian
public class QueryFactory {

    /**
     * returns appropriate query object
     * @param queries input query
     * @return query object
     */
    // @author: A. Sakshi Subramanian
    public static ArrayList<Query> getQueryObject(ArrayList<String> queries) {
        ArrayList<Query> queryObjects = new ArrayList<>();
        for (String query : queries) {
            if (query.trim().contains("start transaction")) queryObjects.add(new BeginTransaction(query));
            else if (query.trim().contains("create database")) queryObjects.add(new CreateDatabase(query));
            else if (query.trim().contains("use")) queryObjects.add(new Use(query));
            else if (query.trim().contains("create")) queryObjects.add(new Create(query));
            else if (query.trim().contains("insert")) queryObjects.add(new Insert(query));
            else if (query.trim().contains("select")) queryObjects.add(new Select(query));
            else if (query.trim().contains("update")) queryObjects.add(new Update(query));
            else if (query.trim().contains("delete")) queryObjects.add(new Delete(query));
            else if (query.trim().contains("commit")) queryObjects.add(new Commit(query));
            else if (query.trim().contains("rollback")) queryObjects.add(new Rollback(query));
            else queryObjects.add(null);
        }
        return queryObjects;
    }
}
```

The screenshot shows the implementation of the **QueryFactory** class in a Java IDE. The class is located in the package `org.customdms.services` and imports `org.customdms.objects.*` and `java.util.ArrayList`. It contains a static method `getQueryObject(ArrayList<String> queries)` that returns an `ArrayList<Query>`. The method iterates over the input queries and creates instances of the appropriate query object based on the query string. The IDE interface shows the project structure on the left, the code editor in the center, and the output console at the bottom.

Figure 3: QueryFactory class implementation

Section 3: Singleton design pattern for Transaction class

The Singleton pattern [3] limits the creation of a class to just one instance within the Java Virtual Machine, guaranteeing that a single instance of the class is maintained. It is essential for the singleton class to offer a universal access point to retrieve the class's instance.

Since this is database supposed to maintain a **single transaction** management system. The system includes a thread safe implementation of singleton transaction class.

The getInstance() method is thread safe returns the transaction instance for the application flow.

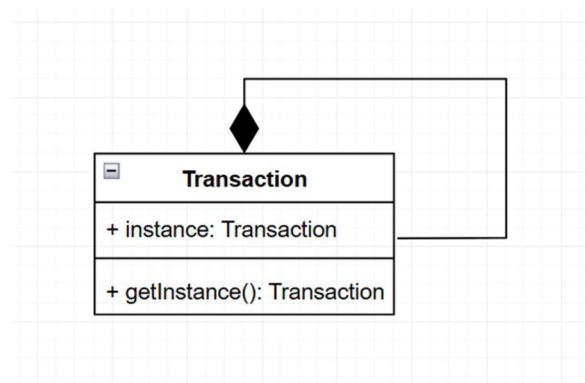


Figure 4: Thread safe singleton transaction class

```
11  */
12  8 usages  ▲ Balaji Sukumaran
13  public class Transaction {
14      3 usages
15      private static volatile Transaction instance;
16      1 usage
17      private static Object mutex = new Object();
18      2 usages
19      private static volatile HashMap<String, LinkedHashMap<Integer, LinkedHashMap<String, String>>> buffer;
20
21      /**
22       * gets the singleton transaction object
23       *
24       * @return transaction object
25       */
26      1 usage  ▲ Balaji Sukumaran
27      public static Transaction getInstance() {
28          Transaction result = instance;
29          if (result == null) {
30              synchronized (mutex) {
31                  result = instance;
32                  if (result == null)
33                      instance = result = new Transaction();
34              }
35          }
36          buffer = new HashMap<>();
37          return result;
38      }
39  }
```

The screenshot shows an IDE with a project structure on the left and the source code of the `Transaction` class in the center. The code implements a thread-safe singleton pattern using a `volatile` static field `instance`, a `mutex` for synchronization, and a `buffer` for storing transaction data. The `getInstance()` method checks if `instance` is null and, if so, synchronizes access to create a new instance.

Figure 5: Thread safe implementation of singleton transaction class

References:

- [1] Priyal Walpita, "Software Architecture Patterns — Layered Architecture," *Medium*, [Online], July 9, 2019. Available: <https://priyalwalpita.medium.com/software-architecture-patterns-layered-architecture-a3b89b71a057> [Accessed: October 24, 2023].
- [2] Arshad Suraj, "Overview Of Factory Method Design Pattern," *Medium*, [Online], May 23, 2021. Available: <https://medium.com/geekculture/overview-of-factory-method-design-pattern-d3a6fe908ea4> [Accessed: October 24, 2023].
- [3] P. Pankaj, "Java Singleton Design Pattern Best Practices with Examples," *digitalocean*, [Online], August 3, 2022. Available: <https://www.digitalocean.com/community/tutorials/java-singleton-design-pattern-best-practices-examples> [Accessed: October 24, 2023].