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Java

Hibernate Architecture, Configuration

Objectives

- **Understand ORM:** Grasp the core concepts and benefits of object-relational mapping.
- **Map Entities:** Efficiently map Java classes to database tables and manage relationships.
- **Control Transactions:** Ensure data integrity with transactions and concurrecy handling.
- **Integrate with Spring:** Leverage Spring Framework for dependency injection and simplified data access.
- **Gain Practical Experience:** Build projects and experiment with advanced features.

Contents

- Introduction
- Key Concepts
- Annotations
- Relationships
- Using Hibernate
- Demo
- Advantages and Disadvantages

What is Hibernate ?

- Hibernate is a powerful object-relational mapping (ORM) framework for the Java programming language.
- It acts as a bridge between the object-oriented world of Java and the relational world of databases, making it easier for developers to work with persistent data.
- Hibernate simplifies Java persistence, allowing developers to focus on the business logic of their applications rather than the intricacies of database interactions.

Key Features of Hibernate

- **ORM:** Maps Java objects to relational database tables, simplifying data access.
- **JPA Implementation:** Adheres to the JPA standard, ensuring portability and flexibility.
- **HQL (Hibernate Query Language):** Powerful object-oriented query language for retrieving and manipulating data.
- **Lazy Loading:** Loads associated data on demand, minimizing data transfer and enhancing responsiveness.
- **Transaction Management:** Ensures data consistency and integrity through transaction support. (Begin Tran, commit, rollback)
- **Inheritance Mapping:** Handles various inheritance scenarios, mapping Java class hierarchies to database tables.

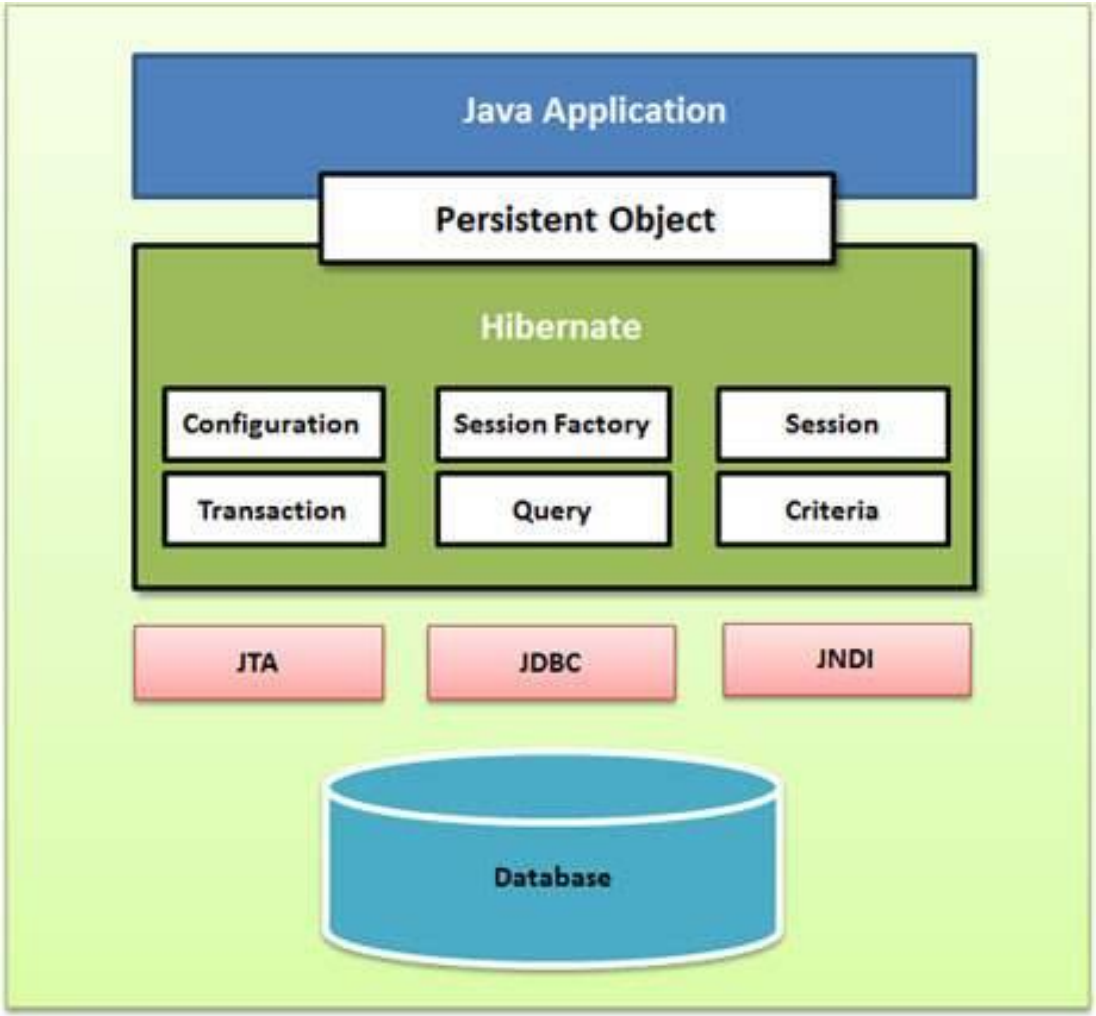
Benefits of Using Hibernate

- **Faster Development:** Spend less time on database code, more time on logic features
- **Cleaner Code:** Write concise, object-oriented code instead of complex SQL.
- **Improved Maintainability:** Easier to understand, update, and refactor your cod ebase.
- **Database Flexibility:** Switch between different databases without major code changes.

Benefits of Using Hibernate

- **Performance Boost:** Caching and lazy loading optimize data access for faster applications.
- **Data Integrity:** Built-in mechanisms ensure data consistency and prevent errors.
- **Industry Standard:** Widely used in the Java ecosystem, making you job-ready.
- **Spring Integration:** Works seamlessly with Spring, the leading Java framework .

Hibernate Architecture



Hibernate Architecture

- **Session Factory:** Manages configuration and creates Sessions
- **Session:** Provides data access methods and interacts with persistent object
- **Persistent Objects:** Java objects representing data stored in the database.
- **Transaction Management:** Ensures data consistency and integrity.
- **Connection Provider:** Handles database connections and pooling.
- **Query API:** Supports HQL, Criteria API, and native SQL for flexible querying
- **Caching:** Optimizes performance with first-level and second-level caches.
- **Event System:** Allows customization of persistence lifecycle events.
- **Dialects:** Generates database-specific SQL for portability.

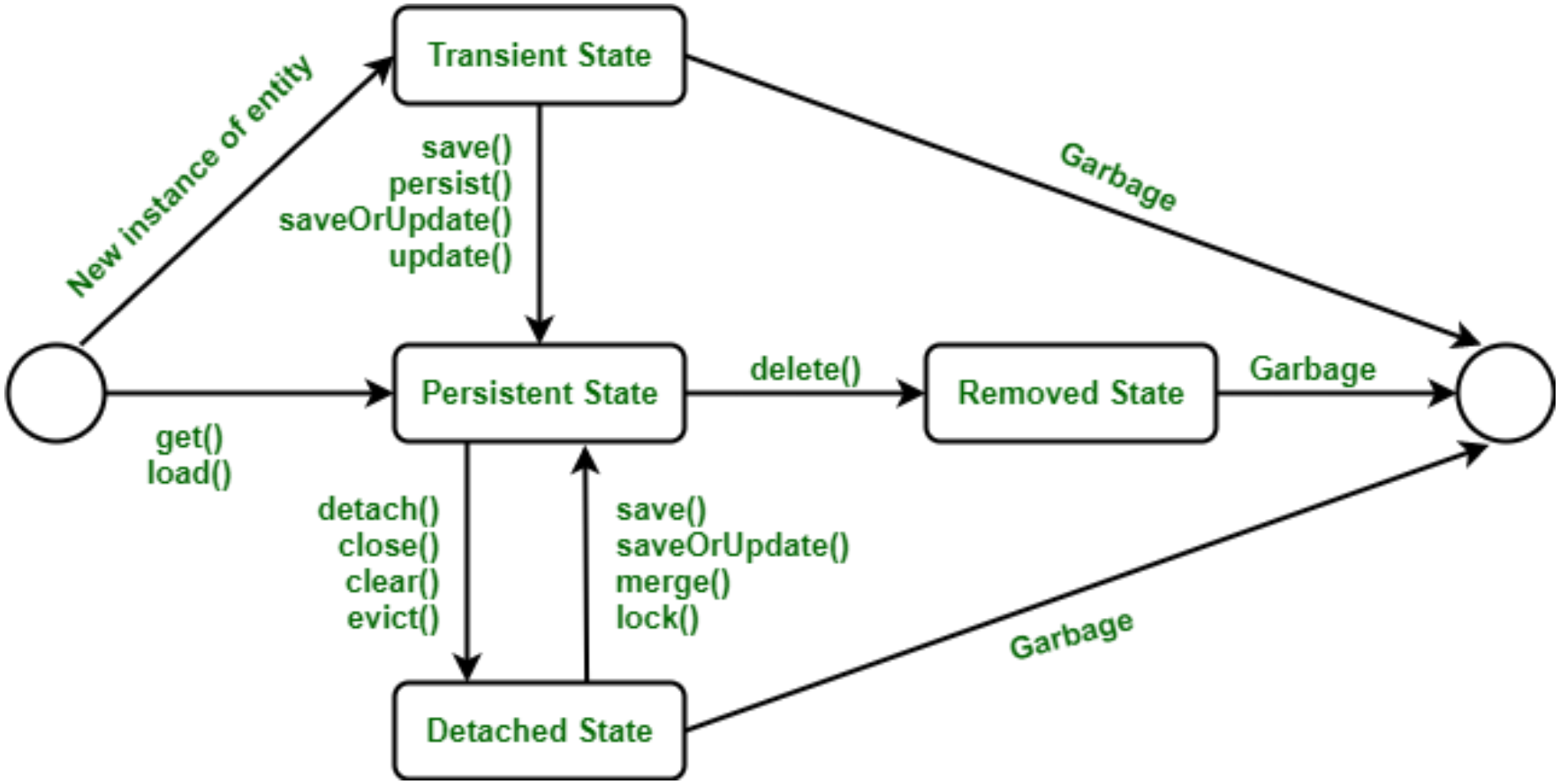
Hibernate Architecture

- **SessionFactory**
  - The SessionFactory is a factory of session and client of ConnectionProvider. It holds second level cache (optional) of data.
  - The **org.hibernate.SessionFactory** interface provides factory method to get the object of Session.
- **Session**
  - The session object provides an interface between the application and data stored in the database. It is a short-lived object and wraps the JDBC connection. It is factory of Transaction, Query and Criteria. It holds a first-level cache (mandatory) of data.
  - The **org.hibernate.Session** interface provides methods to insert, update and delete the object. It also provides factory methods for Transaction, Query and Criteria.

Hibernate Architecture

- **Transaction**
  - The transaction object specifies the atomic unit of work. It is optional. The org.hibernate.Transaction interface provides methods for transaction management.
- **ConnectionProvider**
  - It is a factory of JDBC connections. It abstracts the application from DriverManager or DataSource. It is optional.
- **TransactionFactory**
  - It is a factory of Transaction. It is optional.

Hibernate Lifecycle



Hibernate Lifecycle

- The Hibernate lifecycle refers to the various states an entity instance goes through during its interaction with the persistence framework. Understanding this lifecycle is crucial for effectively managing data and ensuring data integrity in your applications.

- Understanding the Hibernate lifecycle is essential for writing efficient and reliable persistence code. By managing entity states and transitions effectively, you can ensure data integrity and optimize the performance of your applications.

Hibernate Lifecycle

1. Transient State

- An entity instance is in a transient state when it's newly created using the new operator and not yet associated with a Hibernate session.
- Changes made to a transient instance are not tracked by Hibernate and won't be persisted to the database.

Hibernate Lifecycle

2. Persistent State

- An entity instance transitions to the persistent state when it's associated with a Hibernate session. This can happen through:
  - **persist() method:** Explicitly makes an instance persistent.
  - **Cascading:** If an associated entity is persisted and cascading is enabled, the current instance becomes persistent as well.
  - **Querying:** When an entity is retrieved from the database using find(), createQuery (), or other query methods.
- Changes made to a persistent instance are tracked by Hibernate and will be synchro nized with the database upon flushing or transaction commit.

Hibernate Lifecycle

3. Detached State

- An entity instance becomes detached when it's no longer associated with a Hibernate session. This can occur when:
  - **Session is closed:** Closing the session detaches all persistent instances as sociated with it.
  - **detach() method:** Explicitly detaches an instance from the session.
  - **Serialization:** Serializing a persistent instance detaches it.
- Changes made to a detached instance are not tracked by Hibernate and won't be automatically persisted.

Hibernate Lifecycle

4. Removed State

- An entity instance enters the removed state when it's marked for deletion using the remove() method.
- The actual deletion from the database occurs upon flushing or transaction commit.

JPA vs Hibernate

JPA	Hibernate
Java Persistence API (JP.A) defines the management of relational data in the Java applications.	Hibernate is an Object-Relational Mapping (ORM) tool which is used to save the state of Java object into the database.
It is just a specification. Various ORM tools implement it for data persistence.	It is one of the most frequently used JPA implementation.
It is defined in **javax.persistence** package.	It is defined in **org.hibernate** package.
The **EntityManagerFactory** interface is used to interact with the entity manager factory for the persistence unit. Thus, it provides an entity manager.	It uses **SessionFactory** interface to create Session instances.
It uses **EntityManager** interface to create, read, and delete operations for instances of mapped entity classes. This interface interacts with the persistence context.	It uses **Session** interface to create, read, and delete operations for instances of mapped entity classes. It behaves as a runtime interface between a Java application and Hibernate.
It uses **Java Persistence Query Language (JPQL)** as an object-oriented query language to perform database operations.	It uses **Hibernate Query Language (HQL)** as an object-oriented query language to perform database operations.

Hibernate Configuration

- As Hibernate can operate in different environments, it requires a wide range of configuration parameters. These configurations contain the mapping information that provides different functionalities to Java classes. Generally, we provide database related mappings in the configuration file. Hibernate facilitates to provide the configurations either in an XML file (like hibernate.cfg.xml) or properties file (like hibernate.properties).

- An instance of Configuration class allows specifying properties and mappings to applications. This class also builds an immutable **SessionFactory**.

Properties of Hibernate Configuration

- **Hibernate JDBC Properties**

Property	Description
hibernate.connection.driver_class	It represents the JDBC driver class.
hibernate.connection.url	It represents the JDBC URL.
hibernate.connection.username	It represents the database username.
hibernate.connection.password	It represents the database password.
Hibernate.connection.pool_size	It represents the maximum number of connections available in the connection pool.

Properties of Hibernate Configuration

- **Hibernate Datasource Properties**

Property	Description
hibernate.connection.datasource	It represents datasource JNDI name which is used by Hibernate for database properties.
hibernate.jndi.url	It is optional. It represents the URL of the JNDI provider.
hibernate.jndi.class	It is optional. It represents the class of the JNDI InitialContextFactory.

Properties of Hibernate Configuration

Property	Description
hibernate.dialect	It represents the type of database used in hibernate to generate SQL statements for a particular relational database.
hibernate.show_sql	It is used to display the executed SQL statements to console.
hibernate.format_sql	It is used to print the SQL in the log and console.
hibernate.default_catalog	It qualifies unqualified table names with the given catalog in generated SQL.
hibernate.default_schema	It qualifies unqualified table names with the given schema in generated SQL.
hibernate.session_factory_name	The SessionFactory interface automatically bound to this name in JNDI after it has been created.

Properties of Hibernate Configuration

Property	Description
hibernate.default_entity_mode	It sets a default mode for entity representation for all sessions opened from this SessionFactory
hibernate.order_updates	It orders SQL updates on the basis of the updated primary key.
hibernate.use_identifier_rollback	If enabled, the generated identifier properties will be reset to default values when objects are deleted.
hibernate.generate_statistics	If enabled, the Hibernate will collect statistics useful for performance tuning.
hibernate.use_sql_comments	If enabled, the Hibernate generate comments inside the SQL. It is used to make debugging easier.

Hibernate Cache Properties

Property	Description
hibernate.cache.provider_class	It represents the classname of a custom CacheProvider.
hibernate.cache.use_minimal_puts	It is used to optimize the second-level cache. It minimizes writes, at the cost of more frequent reads.
hibernate.cache.use_query_cache	It is used to enable the query cache.
hibernate.cache.use_second_level_cache	It is used to disable the second-level cache, which is enabled by default for classes which specify a mapping.
hibernate.cache.query_cache_factory	It represents the classname of a custom QueryCache interface.
hibernate.cache.region_prefix	It specifies the prefix which is used for second-level cache region names.
hibernate.cache.use_structured_entries	It facilitates Hibernate to store data in the second-level cache in a more human-friendly format.

Properties of Hibernate Configuration

- Hibernate Transaction Properties

Property	Description
hibernate.transaction.factory_class	It represents the classname of a TransactionFactory which is used with Hibernate Transaction API.
hibernate.transaction.manager_lookup_class	It represents the classname of a TransactionManagerLookup. It is required when JVM-level caching is enabled.
hibernate.transaction.flush_before_completion	If it is enabled, the session will be automatically flushed during the before completion phase of the transaction.
hibernate.transaction.auto_close_session	If it is enabled, the session will be automatically closed during the after completion phase of the transaction.

Properties of Hibernate Configuration

- Other Hibernate Properties

Property	Description
hibernate.connection.provider_class	It represents the classname of a custom ConnectionProvider which provides JDBC connections to Hibernate.
hibernate.connection.isolation	It is used to set the JDBC transaction isolation level.
hibernate.connection.autocommit	It enables auto-commit for JDBC pooled connections. However, it is not recommended.
hibernate.connection.release_mode	It specifies when Hibernate should release JDBC connections.
hibernate.current_session_context_class	It provides a custom strategy for the scoping of the "current" Session.
hibernate.hbm2ddl.auto	It automatically generates a schema in the database with the creation of SessionFactory.

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Annotations in Hibernate

Commonly Used Annotations

- **@Entity:** Marks a class as a persistent entity, indicating that it represents data stored in a database table.
- **@Table:** Specifies the name of the database table to which the entity is mapped.
- **@Id:** Identifies the primary key property of the entity.
- **@GeneratedValue:** Configures the strategy for generating identifier values (e.g., AUTO, SEQUENCE, IDENTITY).
- **@Column:** Provides details about the mapping of a property to a database column, s uch as the column name, data type, and nullability.

Commonly Used Annotations

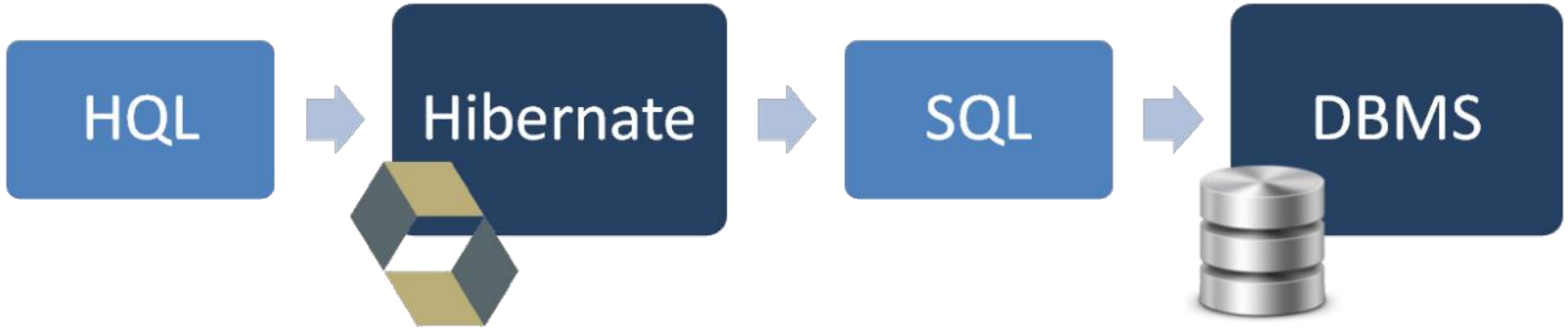
- **@Basic:** Marks a property as a basic type (e.g., String, int, Date).
- **@Transient:** Excludes a property from persistence.
- **@Embedded:** Map embeddable components as value types.
- **@Temporal:** Specifies the temporal precision of a date/time property.
- **@Enumerated:** Configures the mapping of an enum type.
- **@Lob:** Marks a property as a large object (BLOB or CLOB).
- **@Version:** Enables optimistic locking with a version property.
- **@CreationTimestamp, @UpdateTimestamp:** Automatically set timestamps for creation and update events.

Relationships Annotations in Hibernate

- **@ManyToOne:** This annotation defines a many-to-one relationship between two entities.
- **@OneToMany:** This annotation defines a one-to-many relationship between two entities.
- **@OneToOne:** This annotation defines a one-to-one relationship between two entities.
- **@ManyToMany:** This annotation defines a many-to-many relationship between two entities.

Hibernate Query Language (HQL)

- Hibernate Query Language (HQL) is same as SQL (Structured Query Language) but it doesn't depends on the table of the database. Instead of table name, we use class name in HQL. So it is database independent query language.



Advantage of HQL

- Database independent
- Supports polymorphic queries
- Easy to learn for Java Programmer

Query Interface

- It is an object oriented representation of Hibernate Query. The object of Query can be obtained by calling the createQuery() method Session interface.
  - **public int executeUpdate()** is used to execute the update or delete query.
  - **public List list()** returns the result of the ralation as a list.
  - **public Query setFirstResult(int rowno)** specifies the row number from where record will be retrieved.

Query Interface

- **public Query setMaxResult(int rowno)** specifies the no. of records to be retrieved from the relation (table).
- **public Query setParameter(int position, Object value)** it sets the value to the JDBC style query parameter.
- **public Query setParameter(String name, Object value)** it sets the value to a named query parameter.

Example of HQL paging

- Query query=session.createQuery("from Student");
- query.setFirstResult(5);
- query.setMaxResult(10);
- List list=query.list();//will return the records from 5 to 10th number

Example of HQL update query


```
1. Transaction tx=session.beginTransaction();
2. Query q=session.createQuery("update Student set lastName=:n where id=:i");
3. q.setParameter("n",“Sang");
4. q.setParameter("i",1);
5. int status=q.executeUpdate();
6. System.out.println(status);
7. tx.commit();
```

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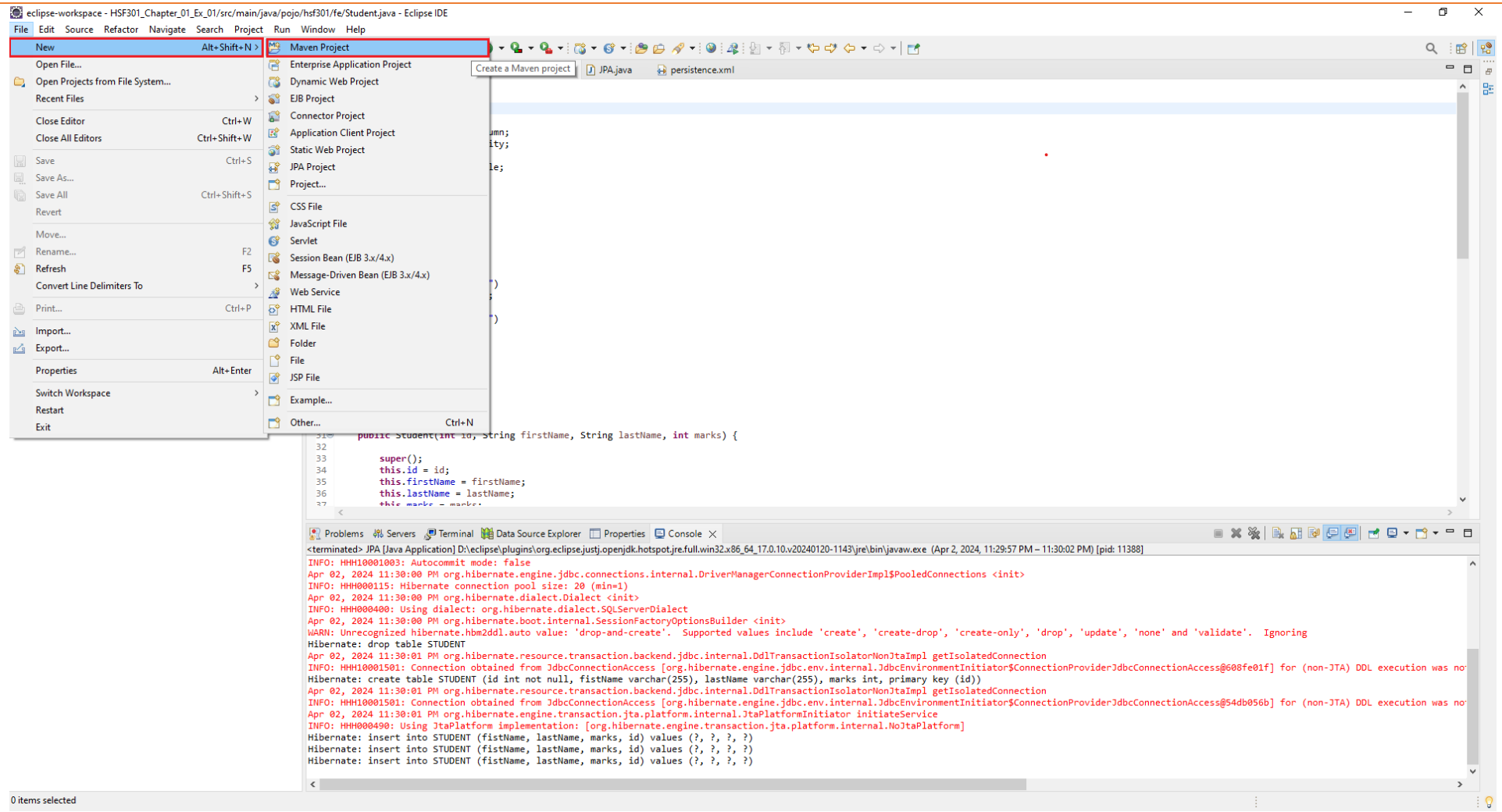
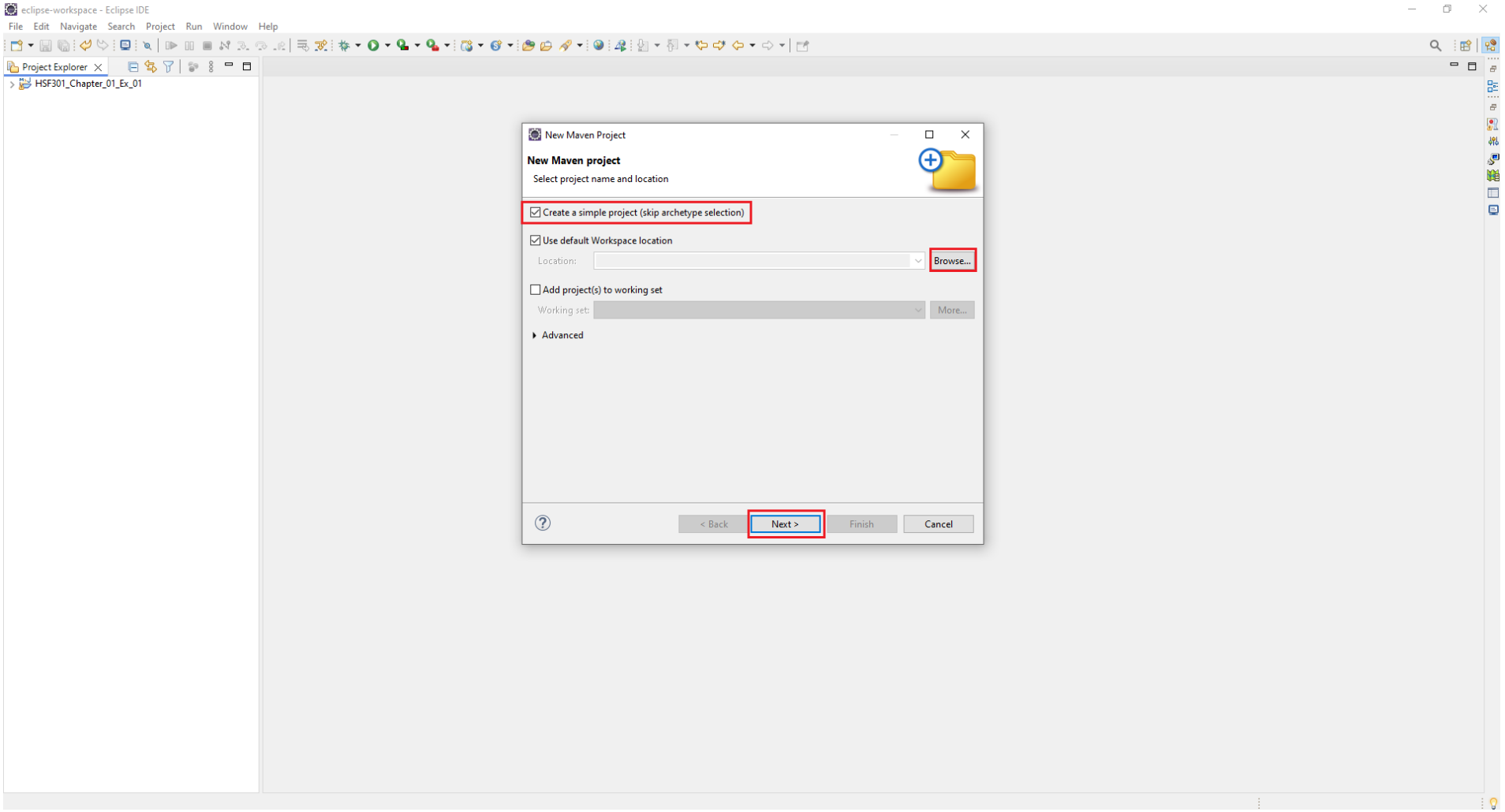
Java

Demo Hibernate (One To Many)

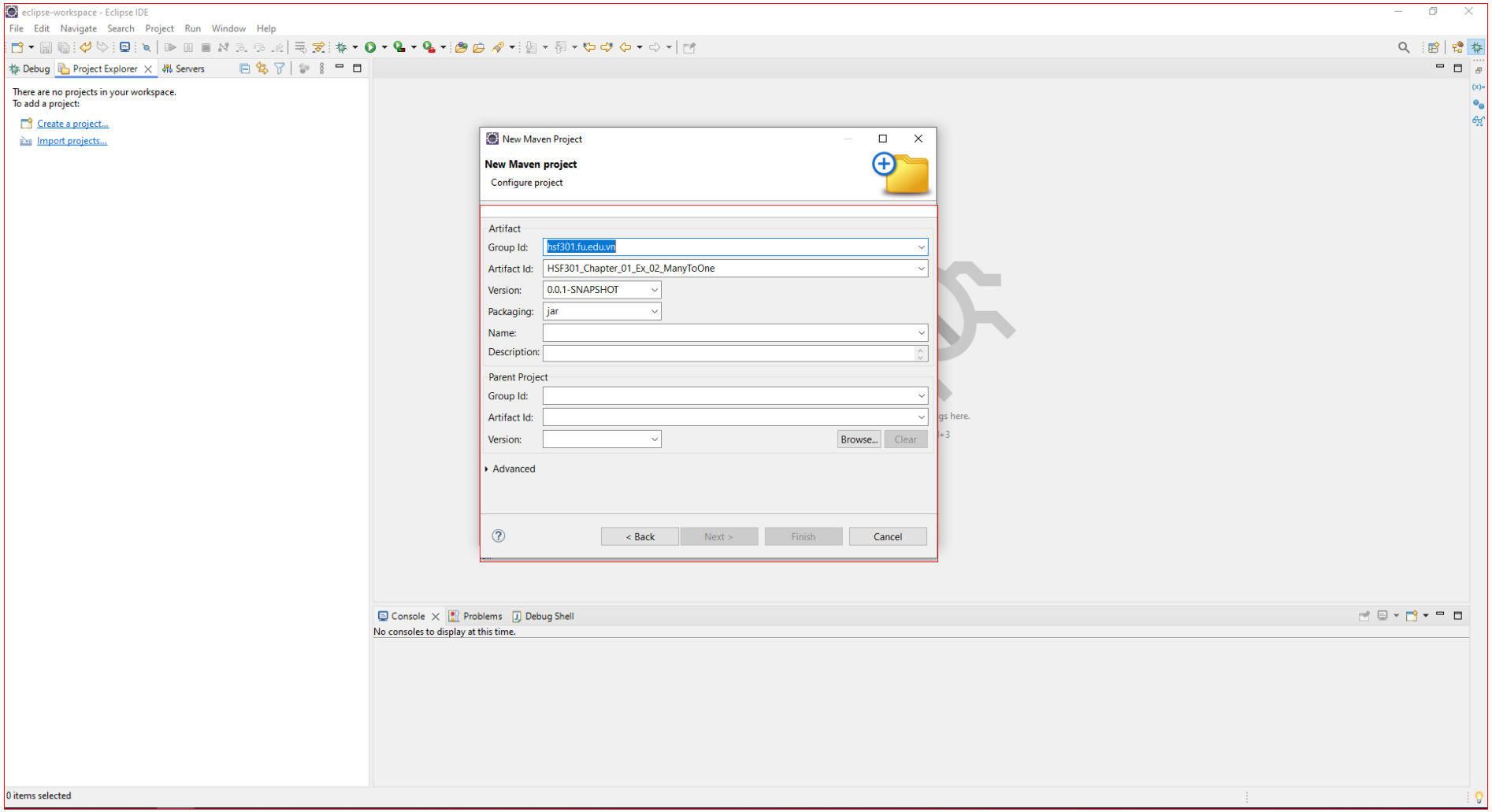
1. Open Eclipse, File | New | Maven Project



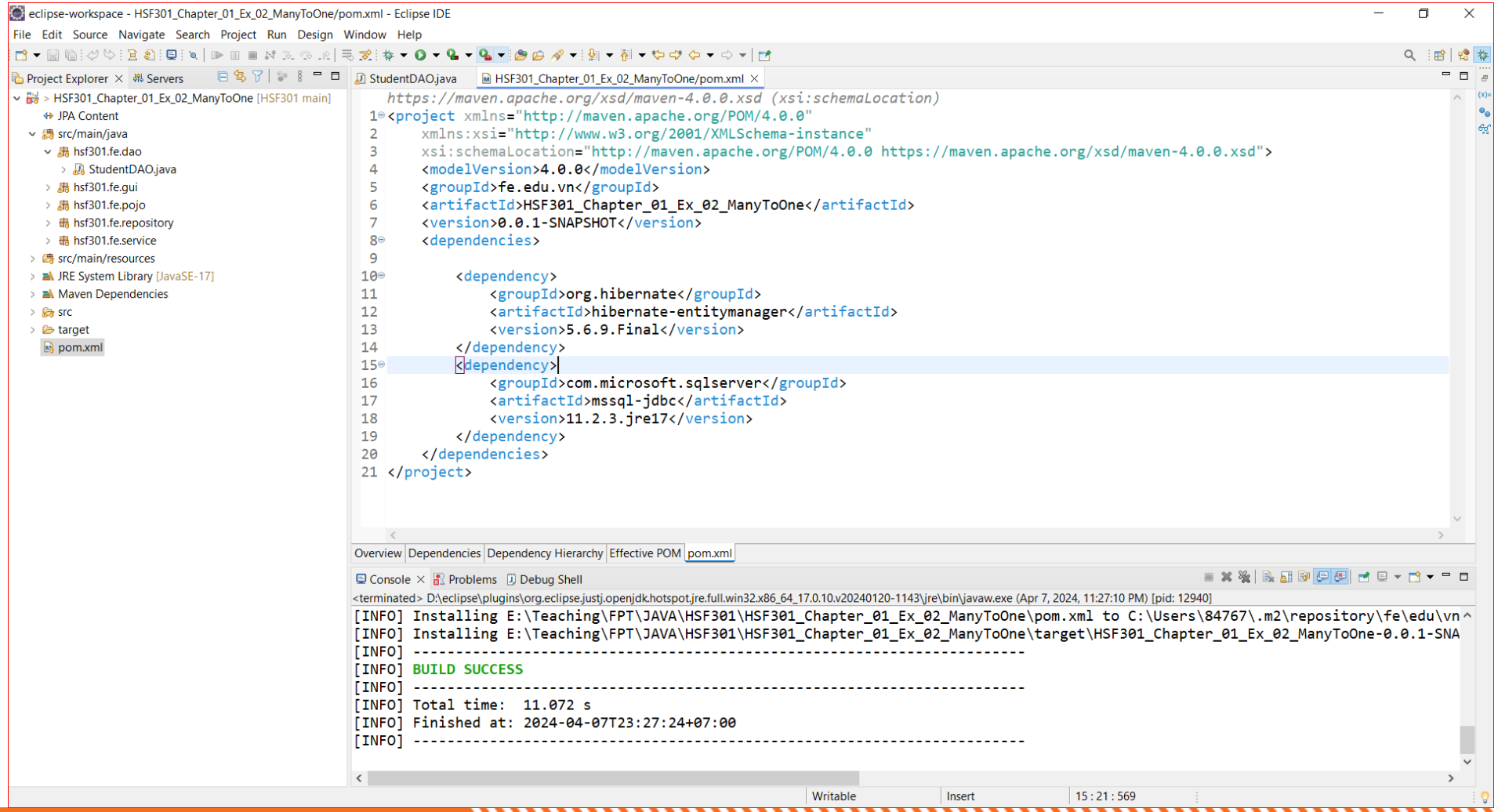
2. Check Create a simple project -> Browse Project -> Next



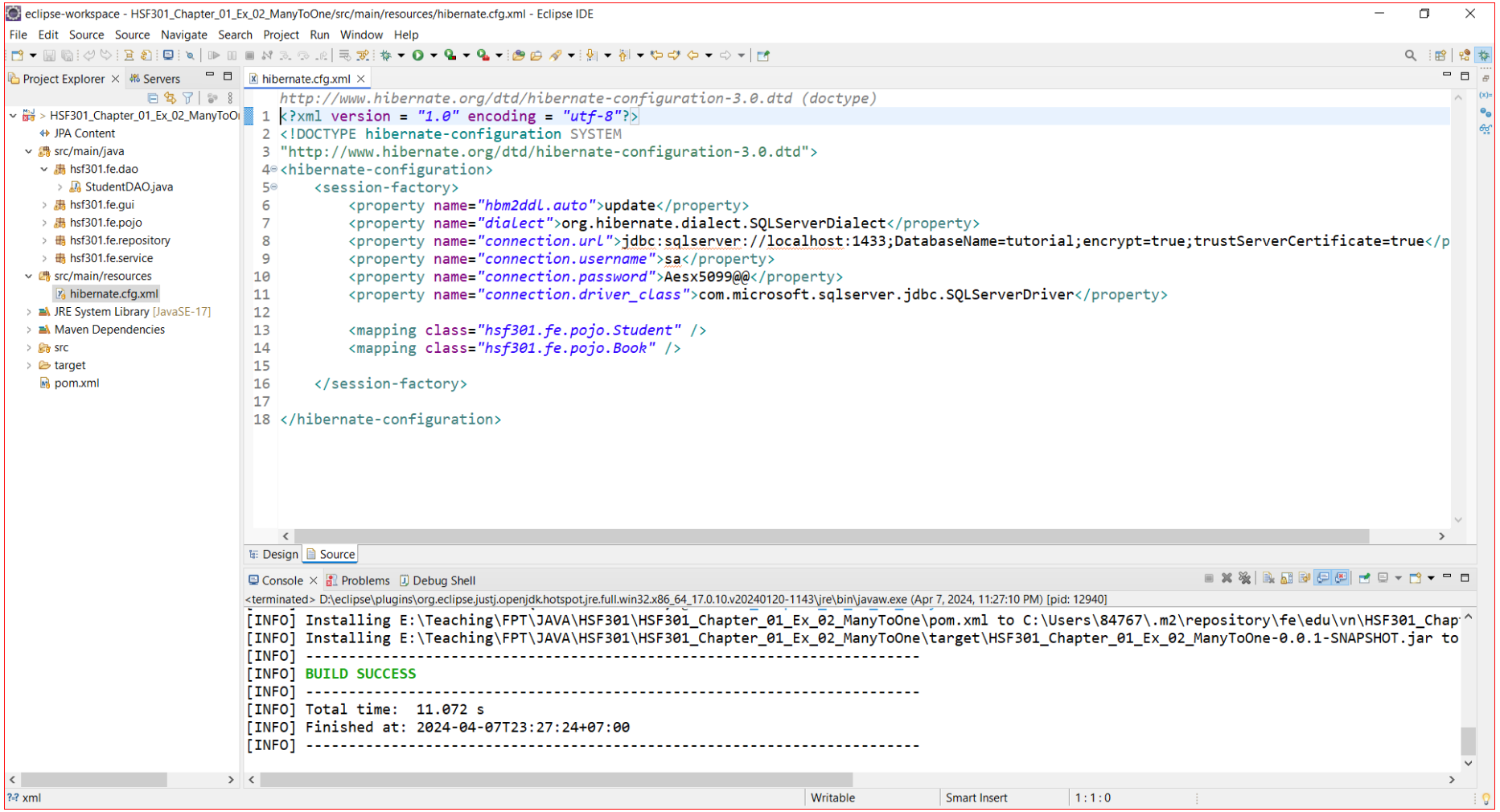
3. Fill the information Project -> Click Finish



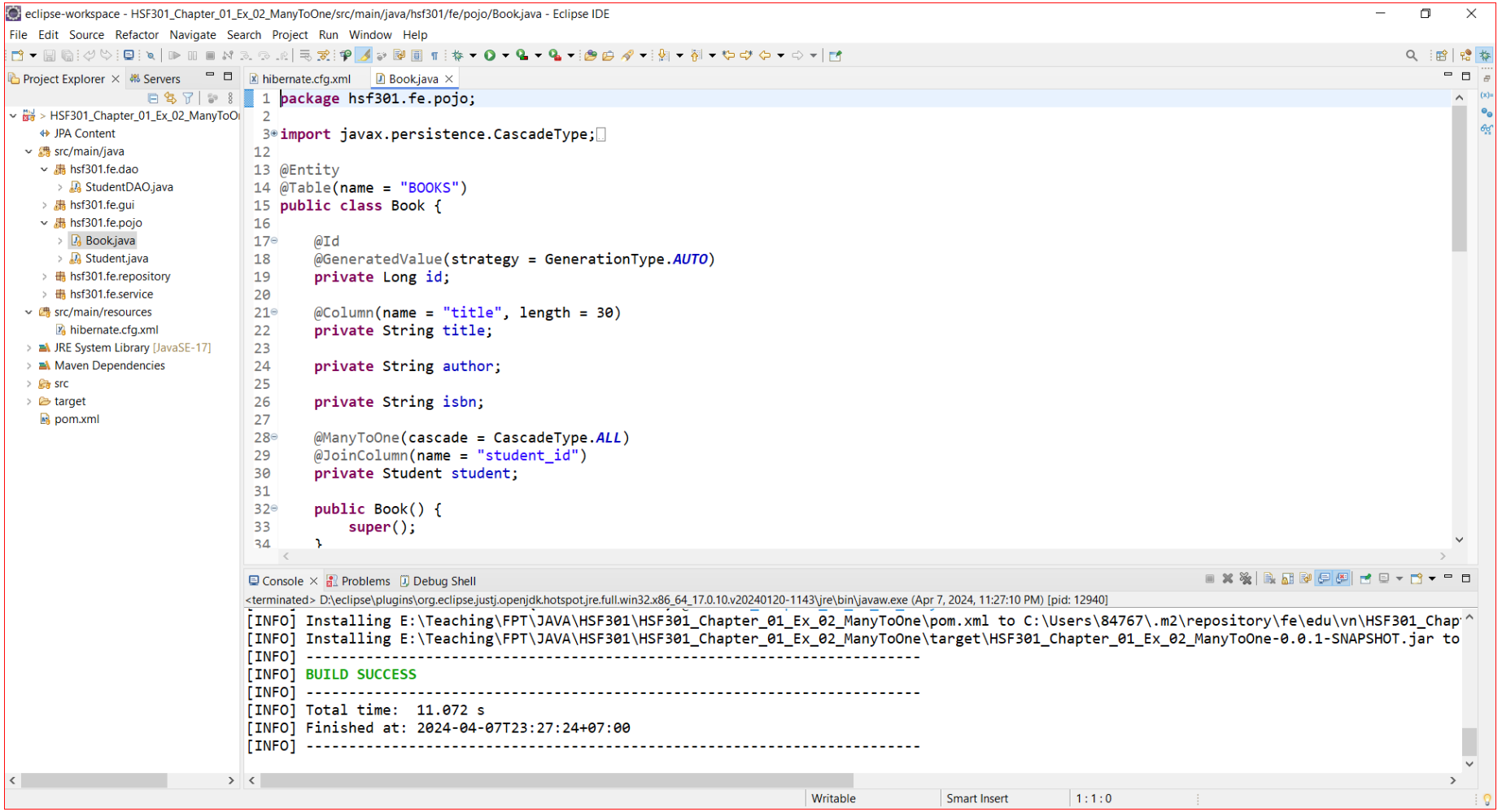
4. Structure of Maven Project



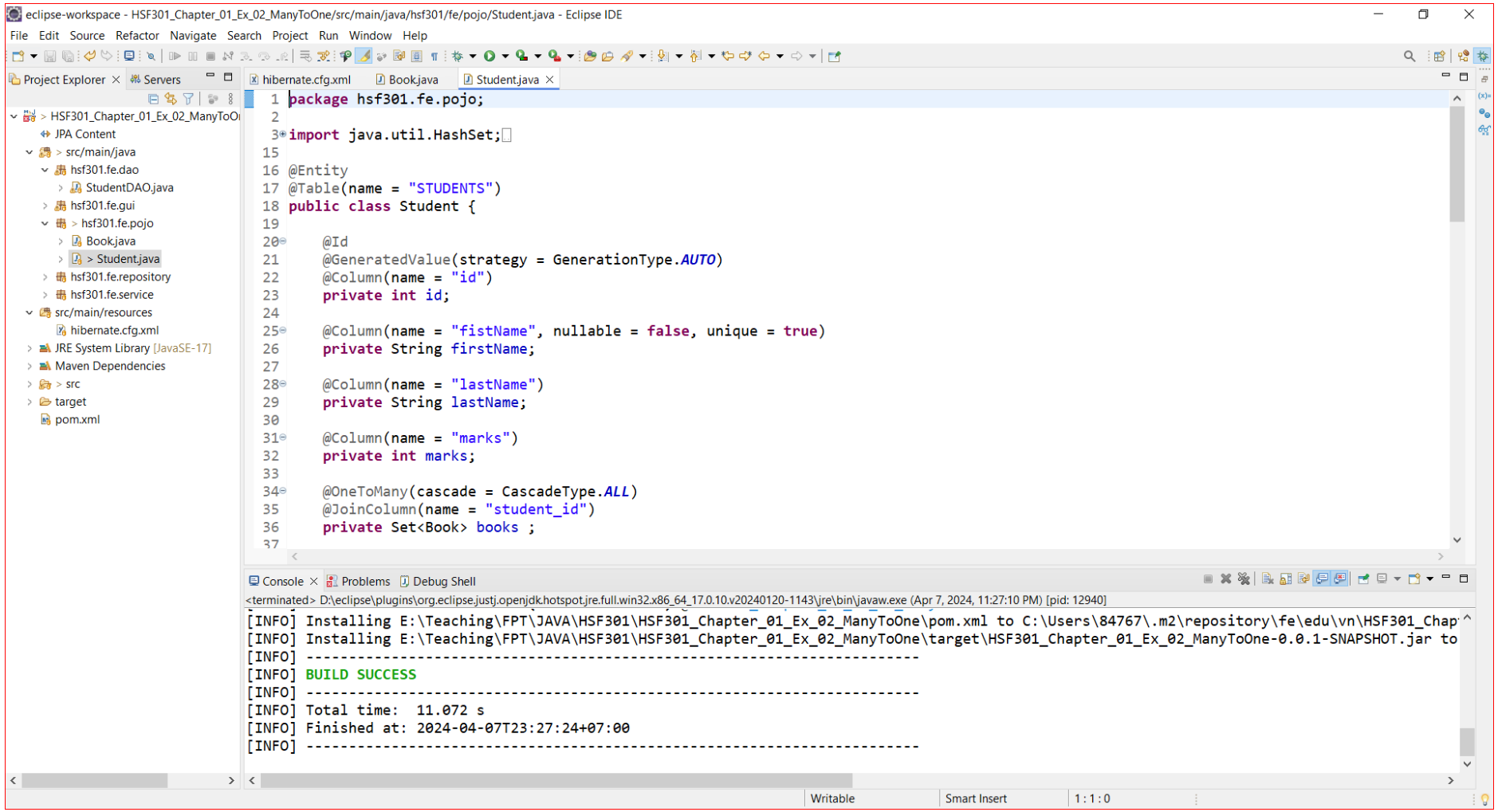
5. Create hibernate.cfg.xml



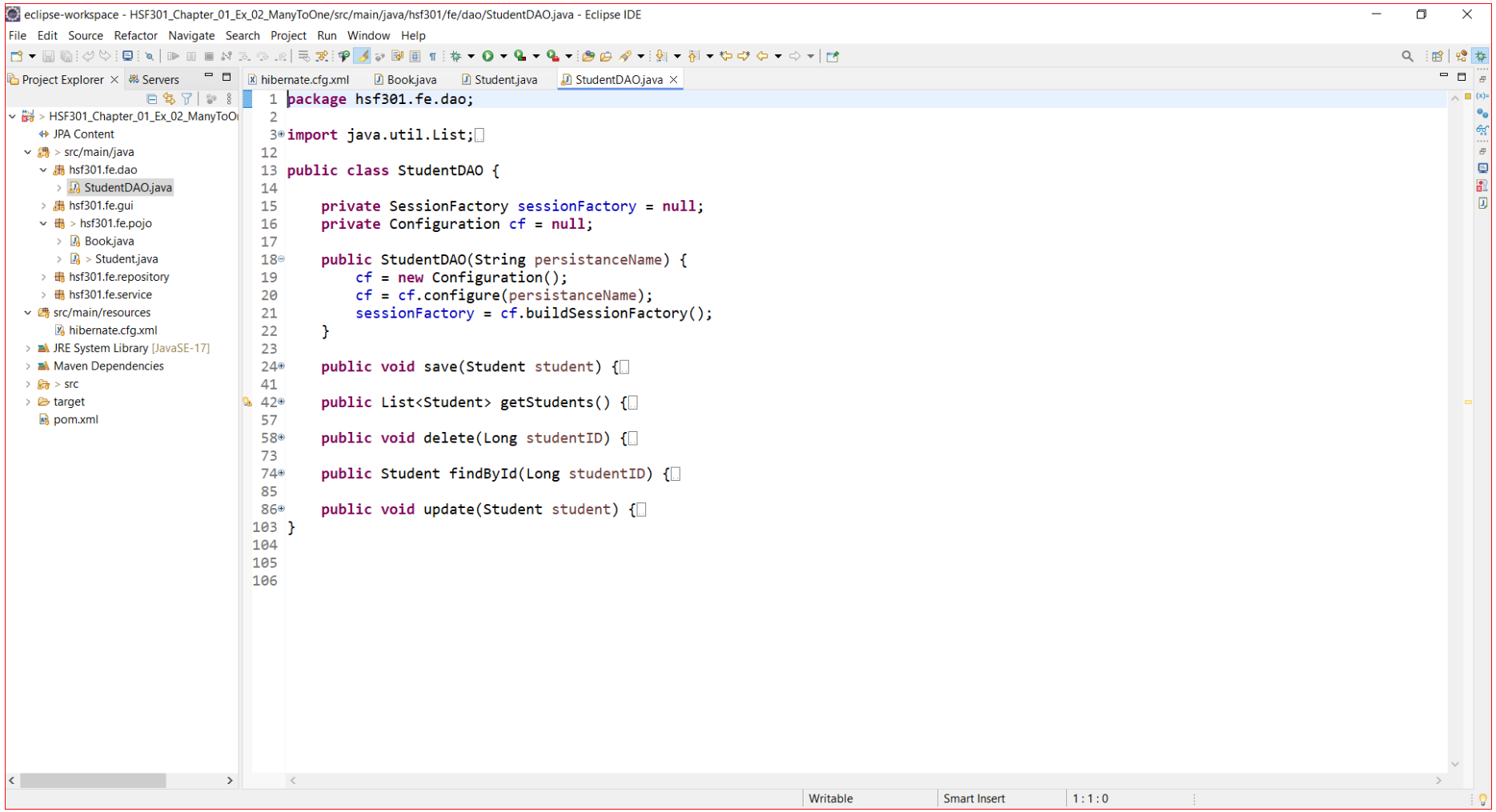
6. Create Books in Pojo



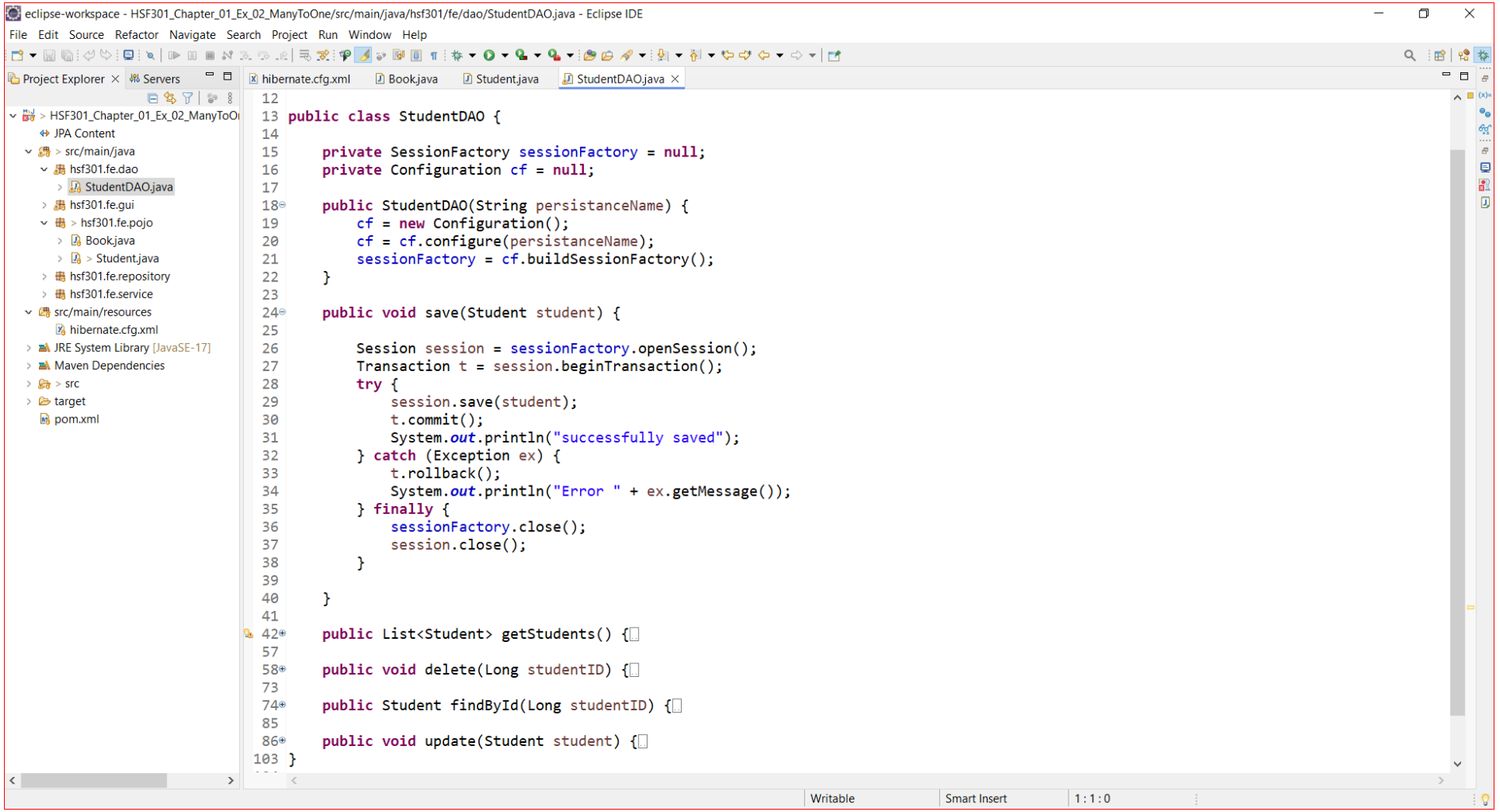
7. Create Students in Pojo



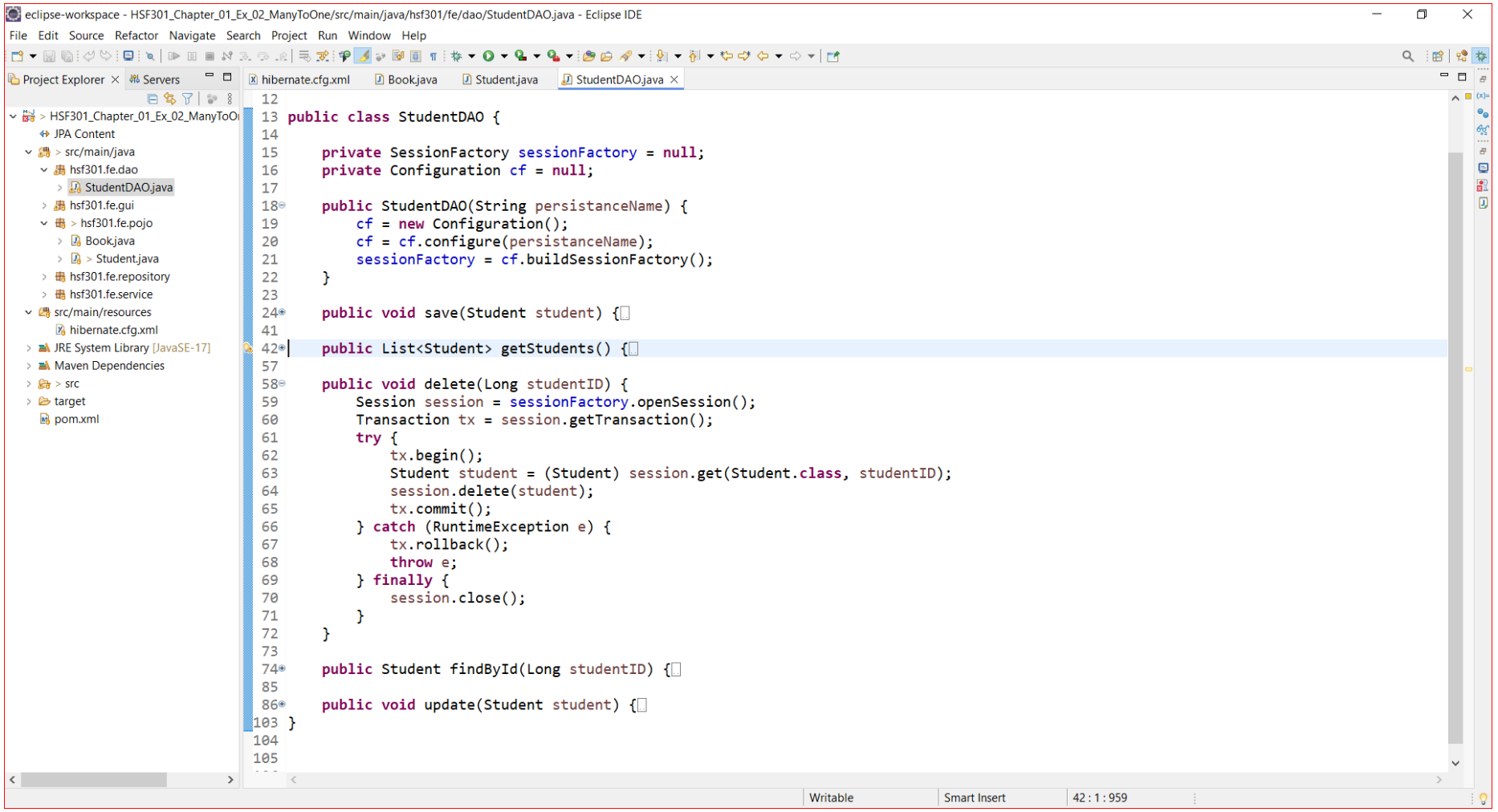
8. Create StudentDAO



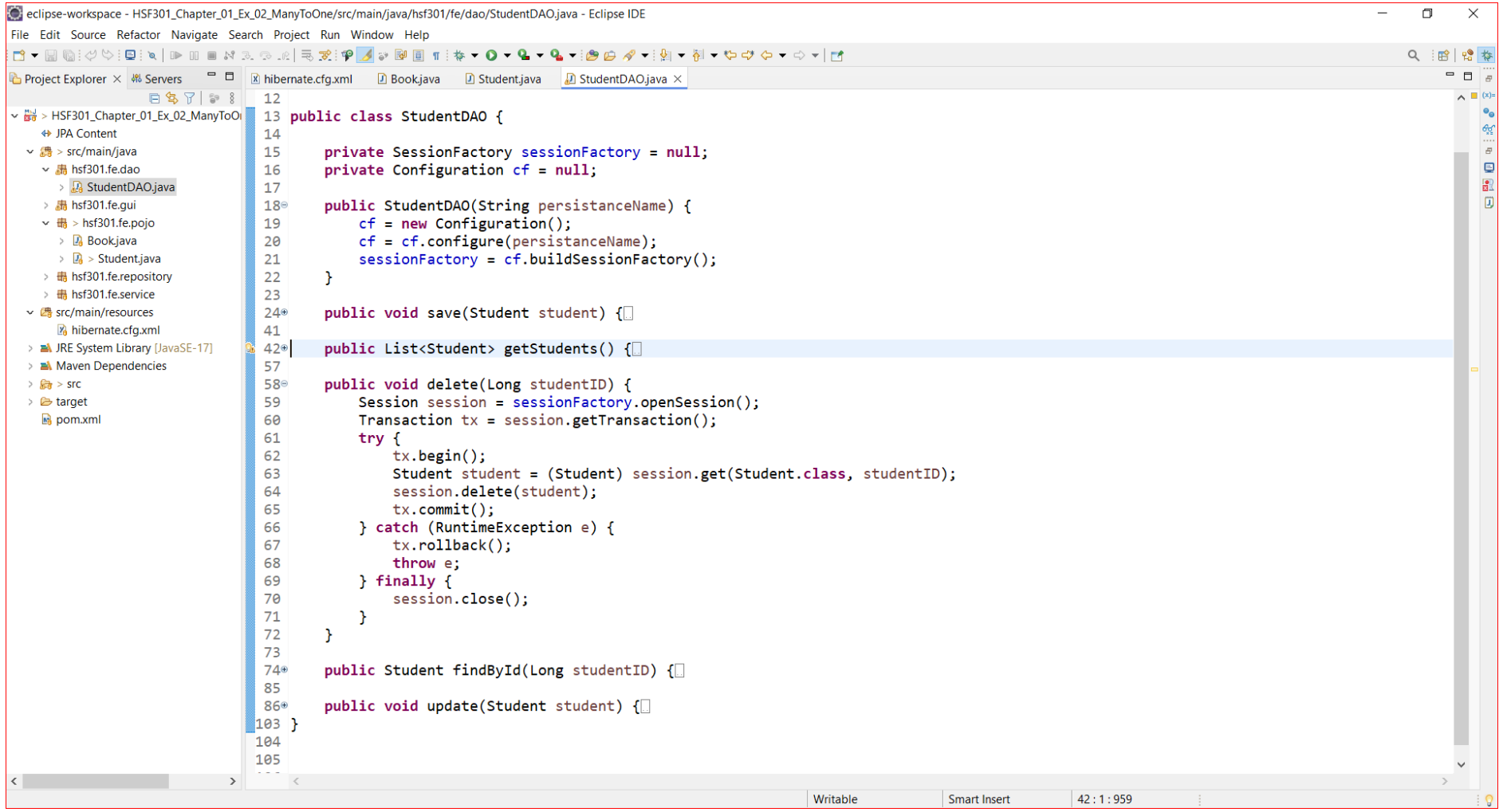
9. Save Student in StudentDAO



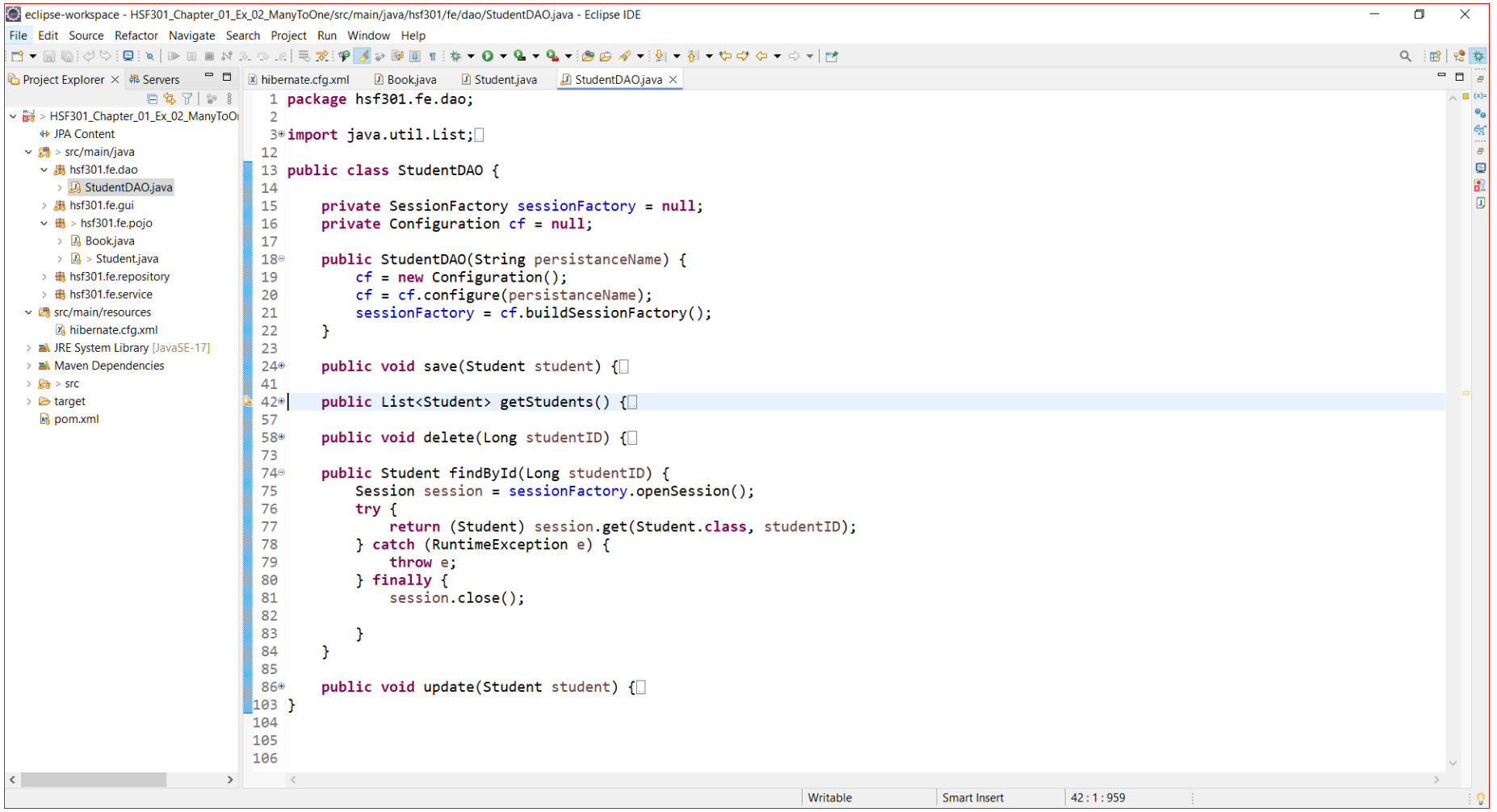
10. Get All Student in StudentDAO



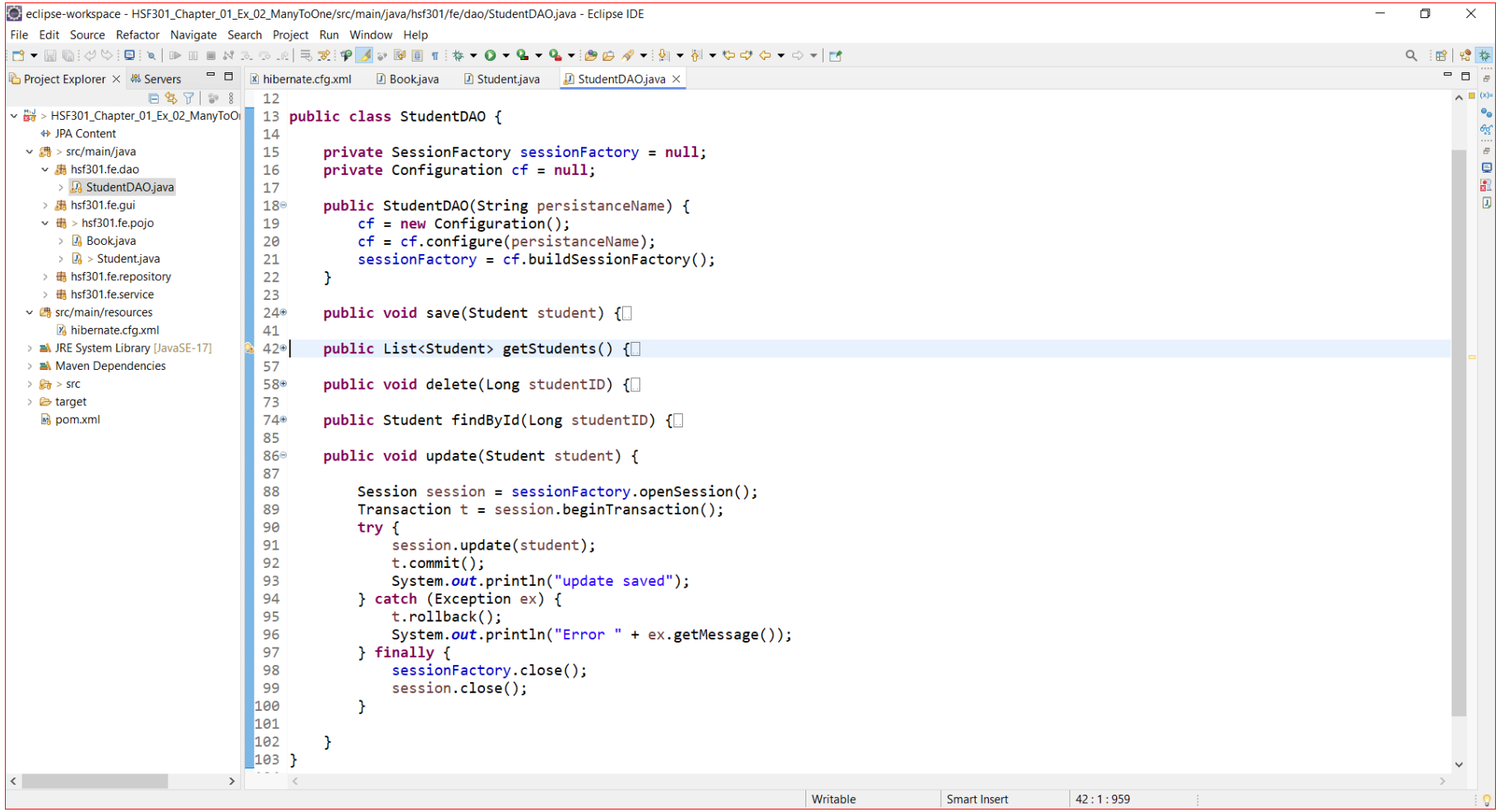
11. Delete Student in StudentDAO



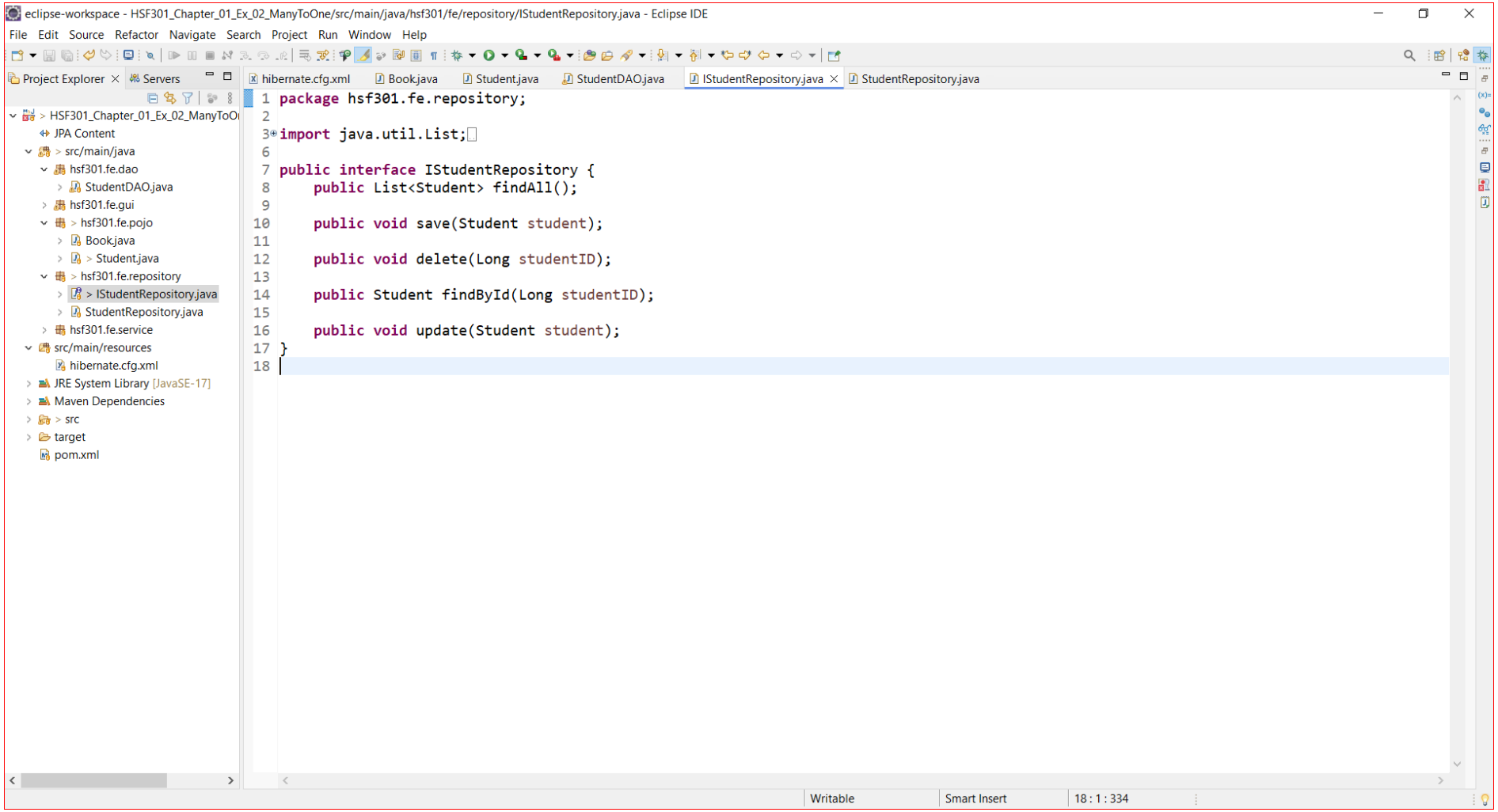
12. Find A Student in StudentDAO



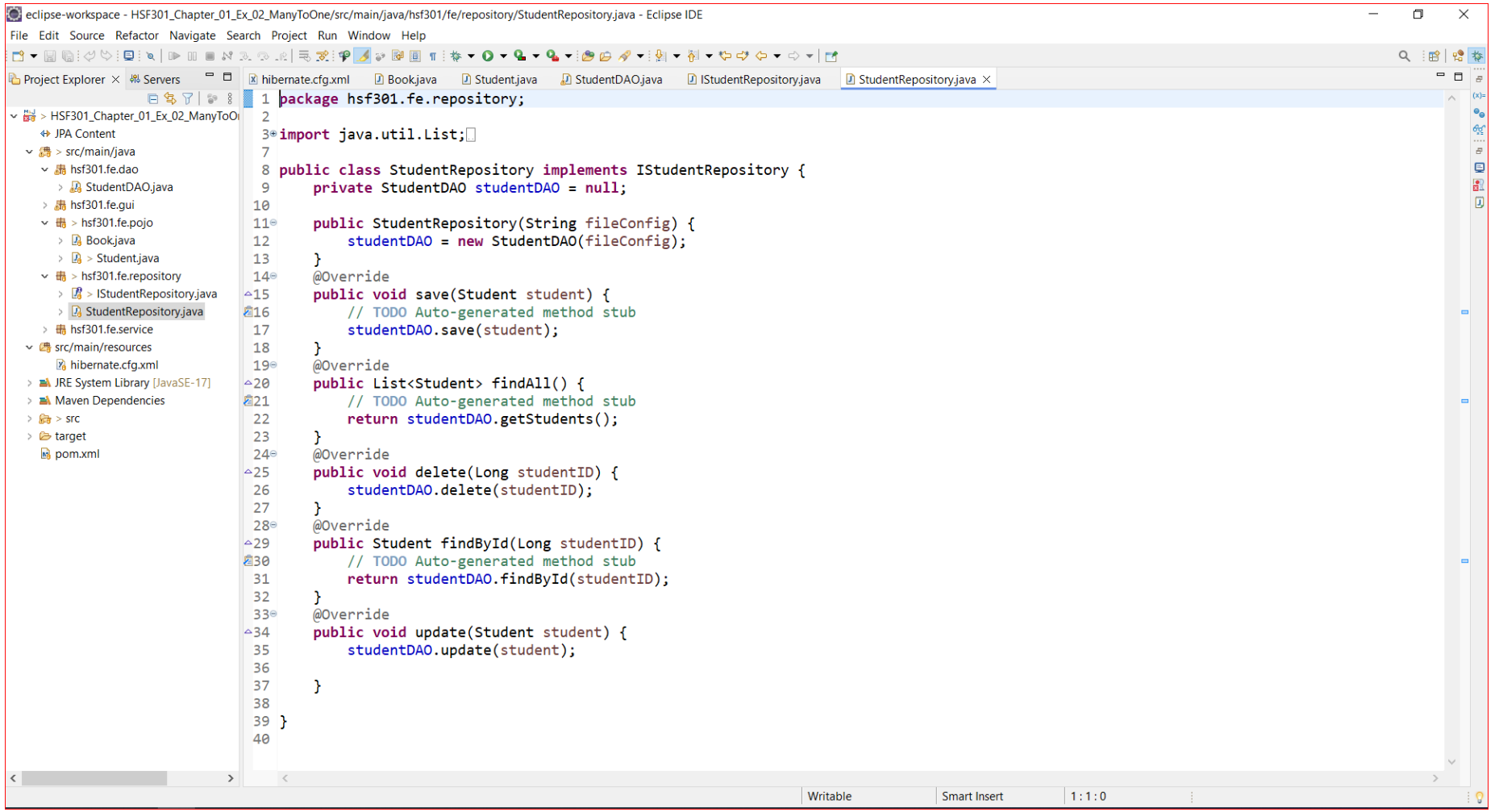
13. Update a Student in StudentDAO



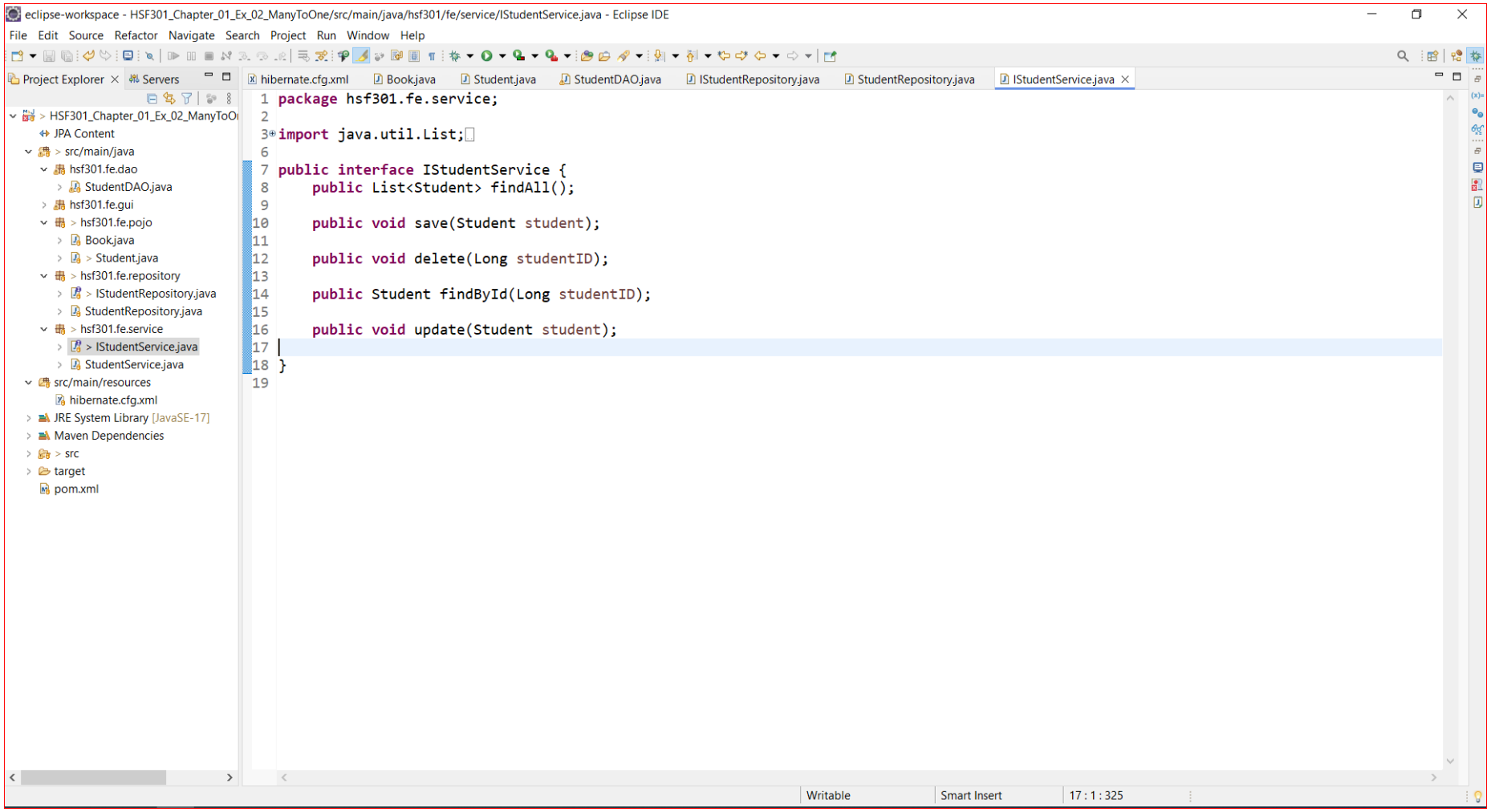
14. Create IStudentRepository



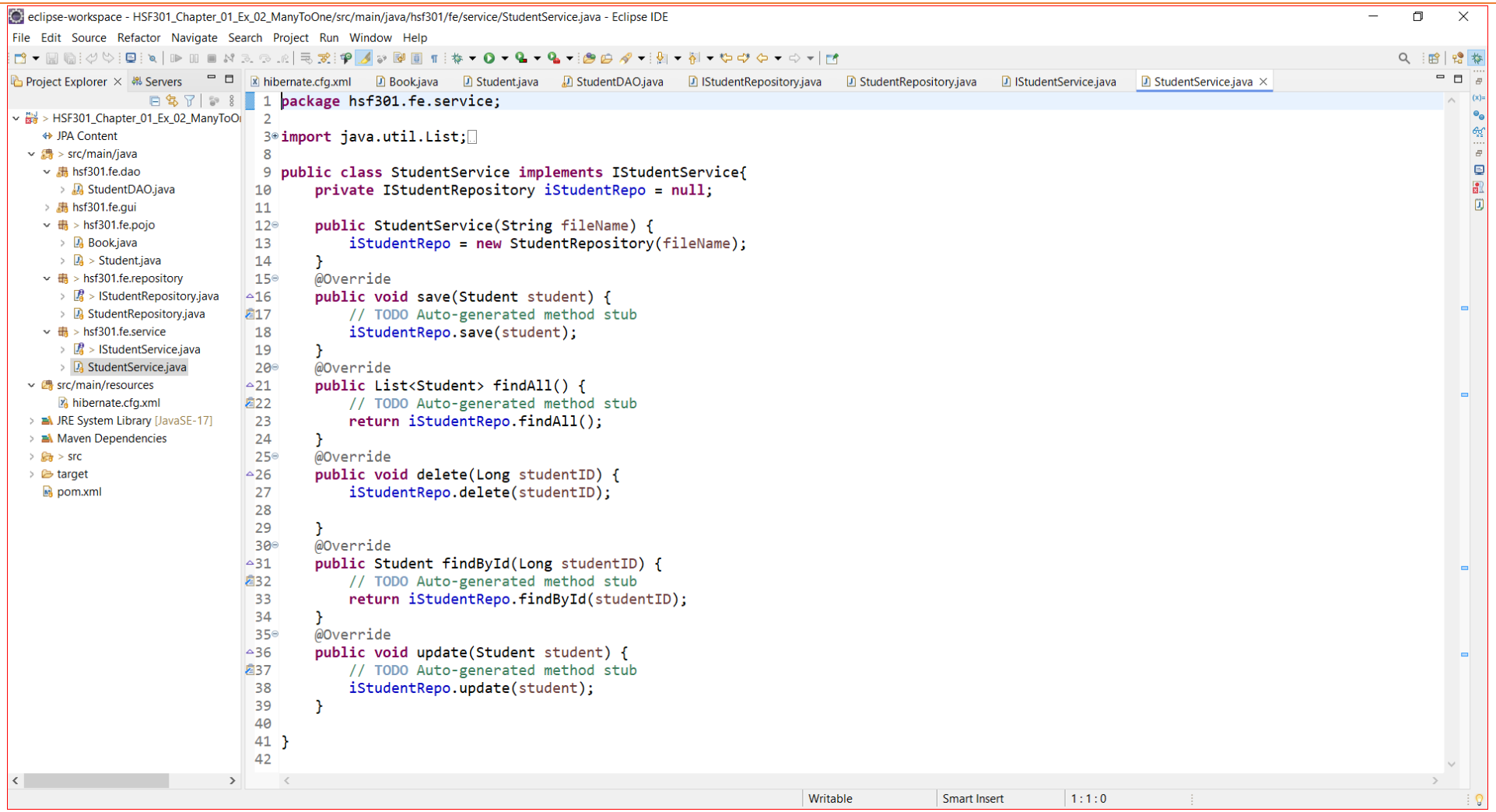
15. Create StudentRepository



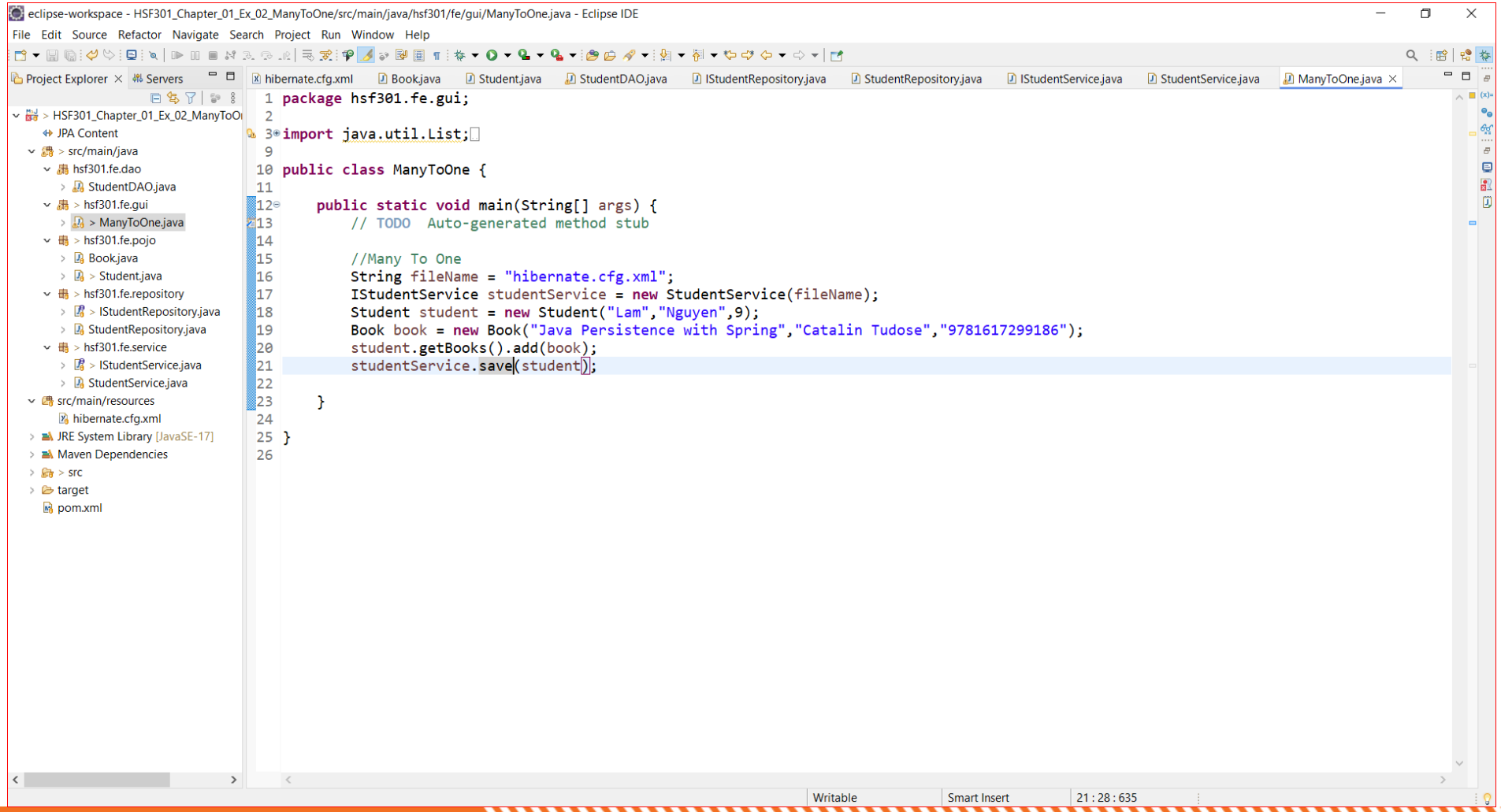
16. Create IStudentService



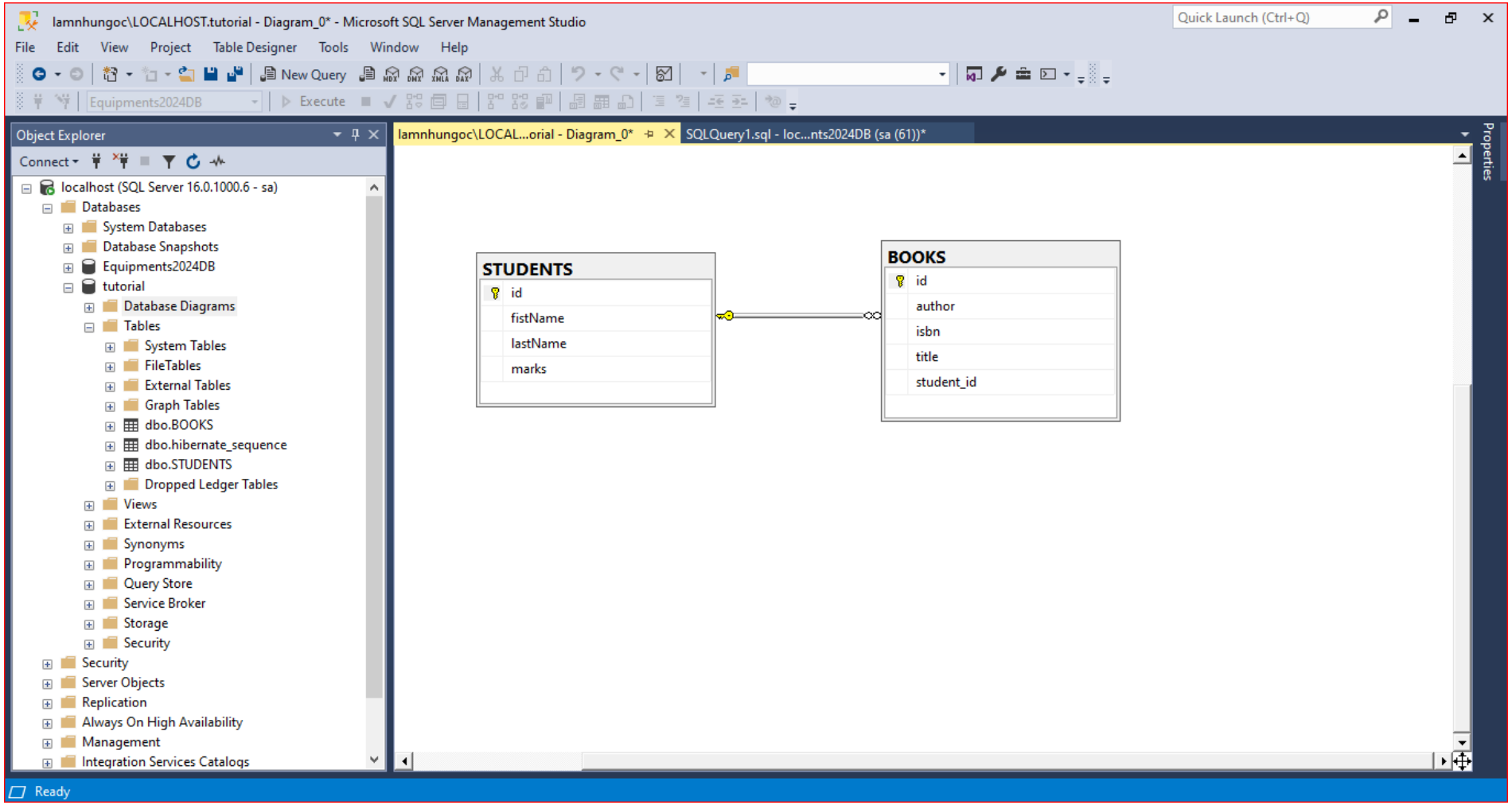
17. Create StudentService



18. Create Main function



19. Result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Database Diagrams
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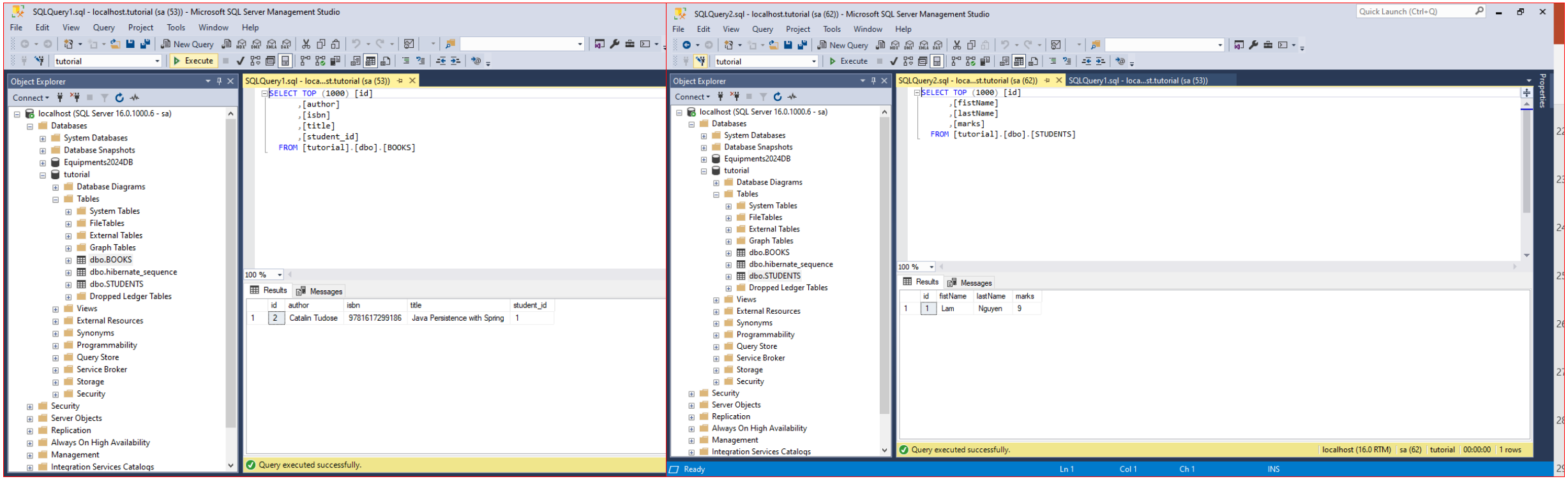
20. Result


SQLQuery1.sql - localhost.tutorial (sa (53)) - Microsoft SQL Server Management Studio
SELECT TOP (1000) [id]
,[author]
,[isbn]
,[title]
,[student_id]
FROM [tutorial].[dbo].[BOOKS]
id author isbn title student_id
1 2 Catalin Tudose 9781617299186 Java Persistence with Spring 1
Query executed successfully.
SQLQuery2.sql - localhost.tutorial (sa (62)) - Microsoft SQL Server Management Studio
SELECT TOP (1000) [id]
,[fistName]
,[lastName]
,[marks]
FROM [tutorial].[dbo].[STUDENTS]
id fistName lastName marks
1 1 Lam Nguyen 9
Query executed successfully.
Ready

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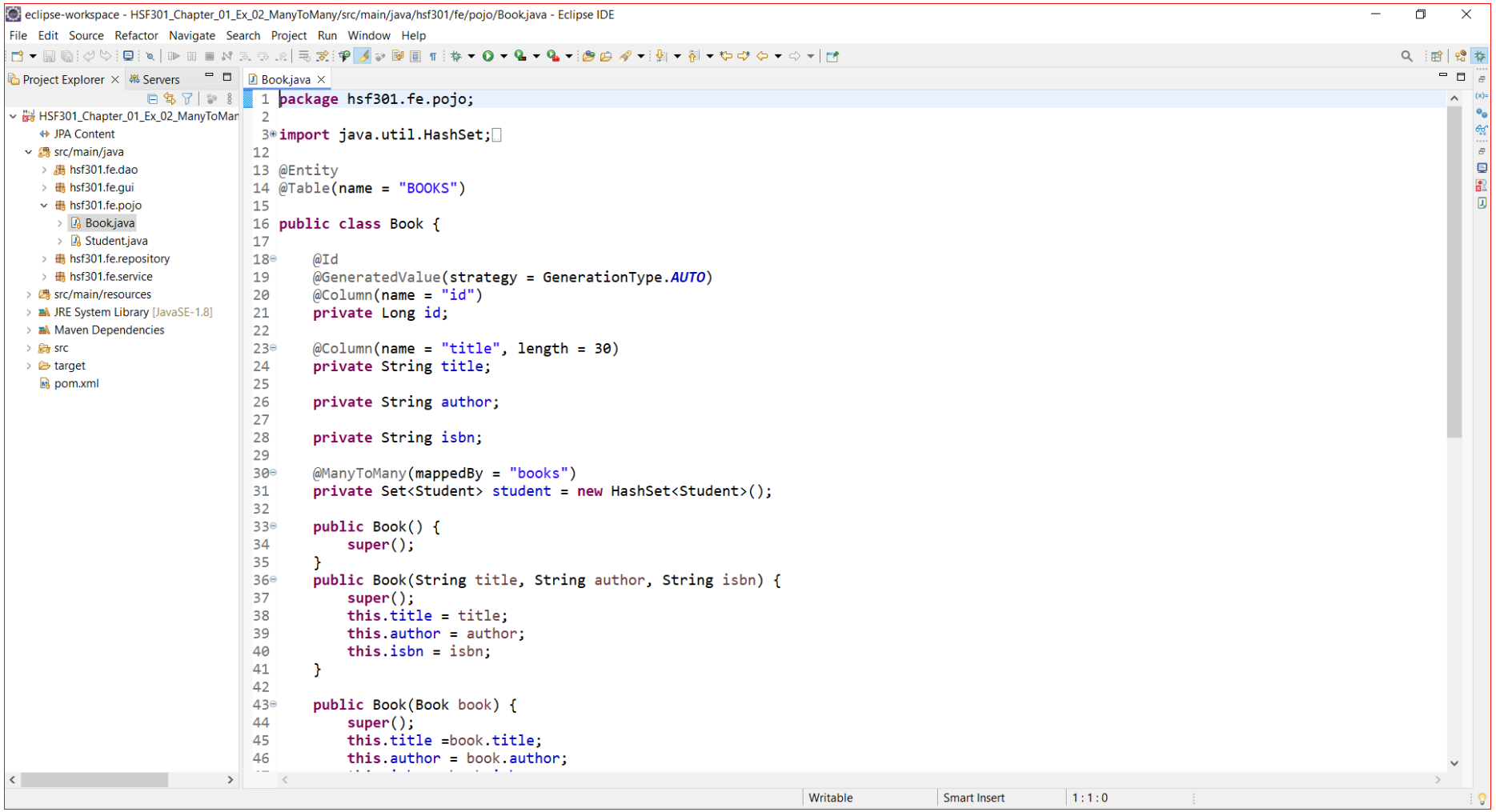
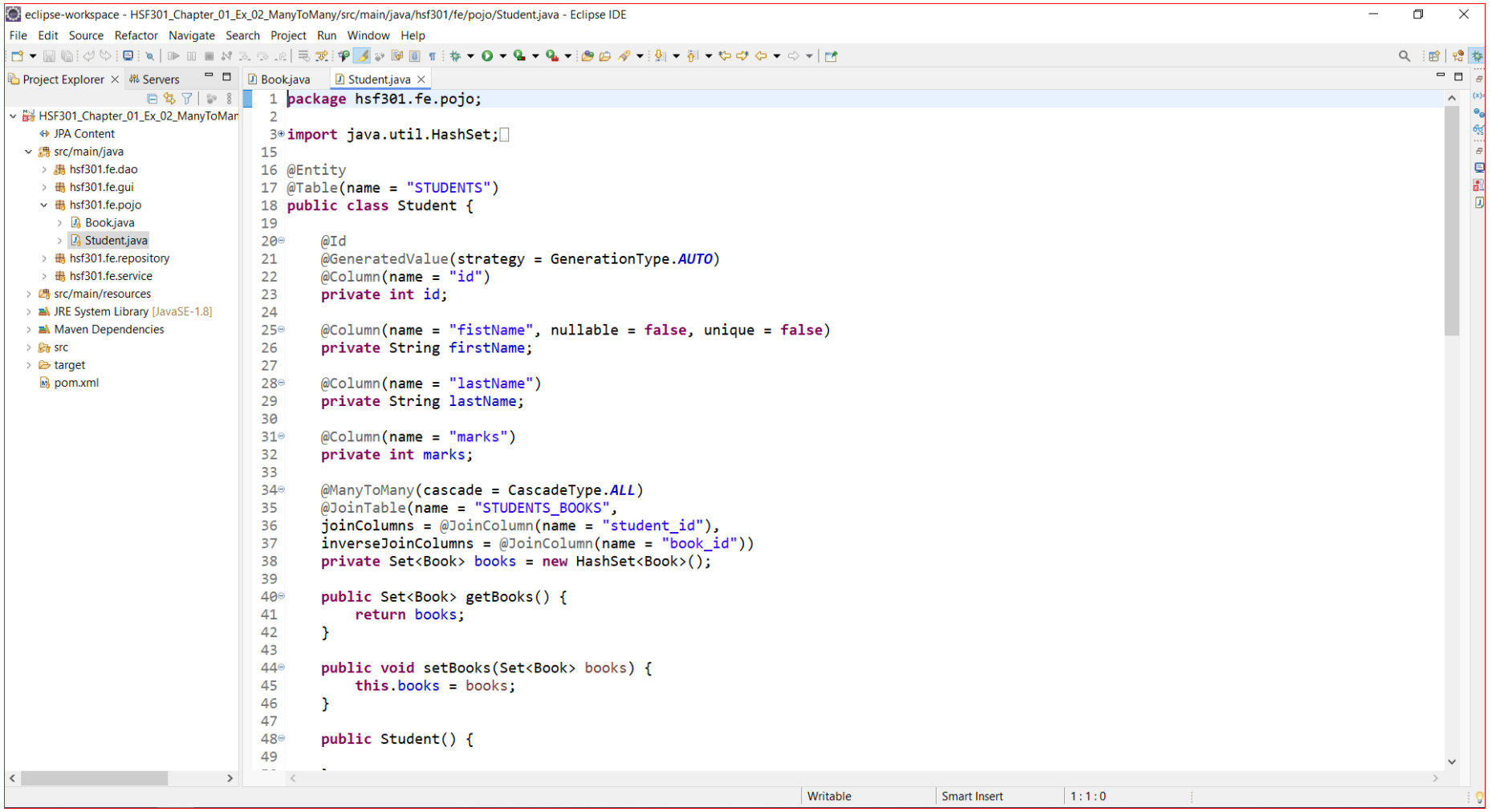
Demo JPA
(Many To Many)

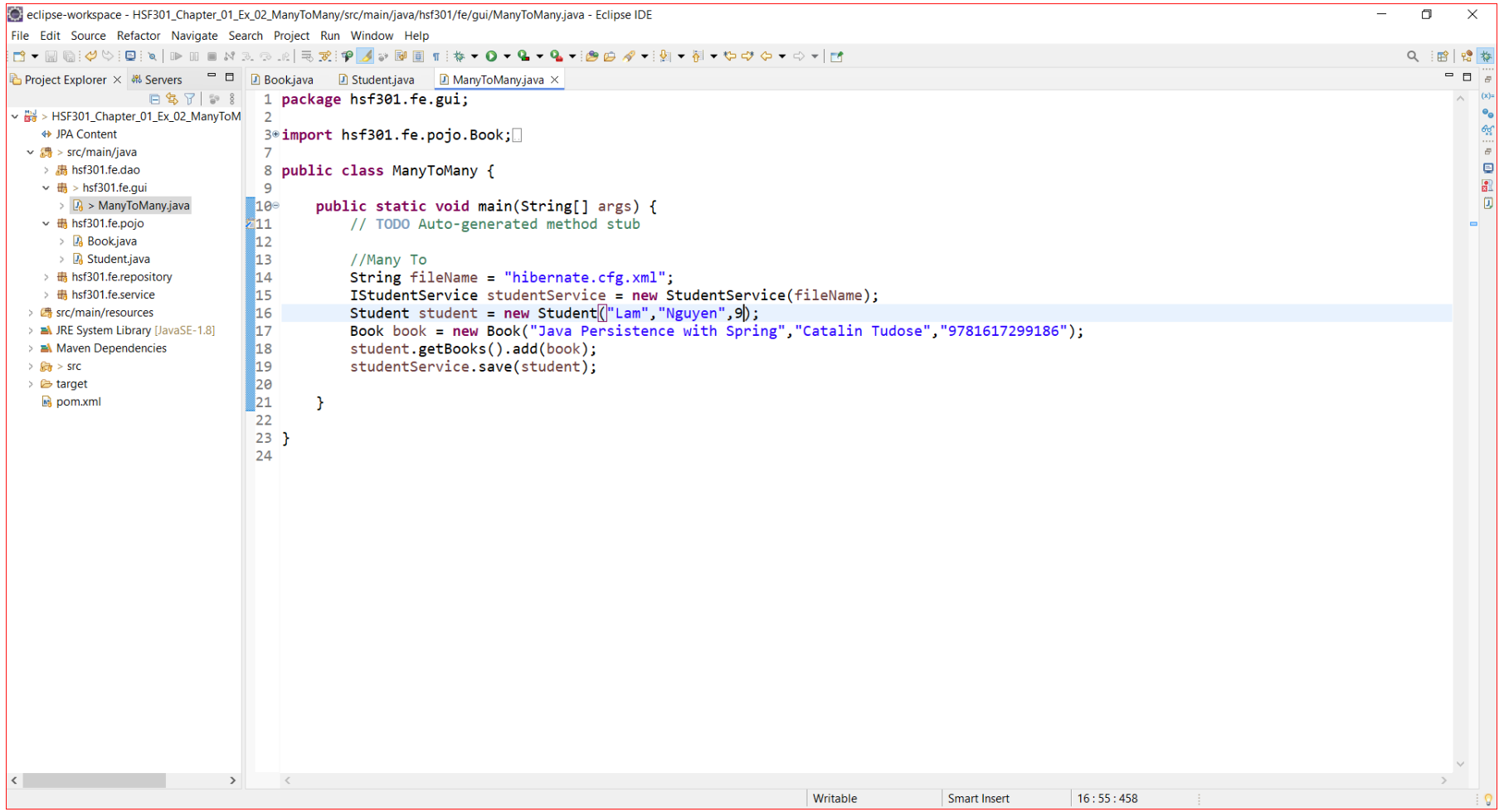
1. Create Books in Pojo's Package



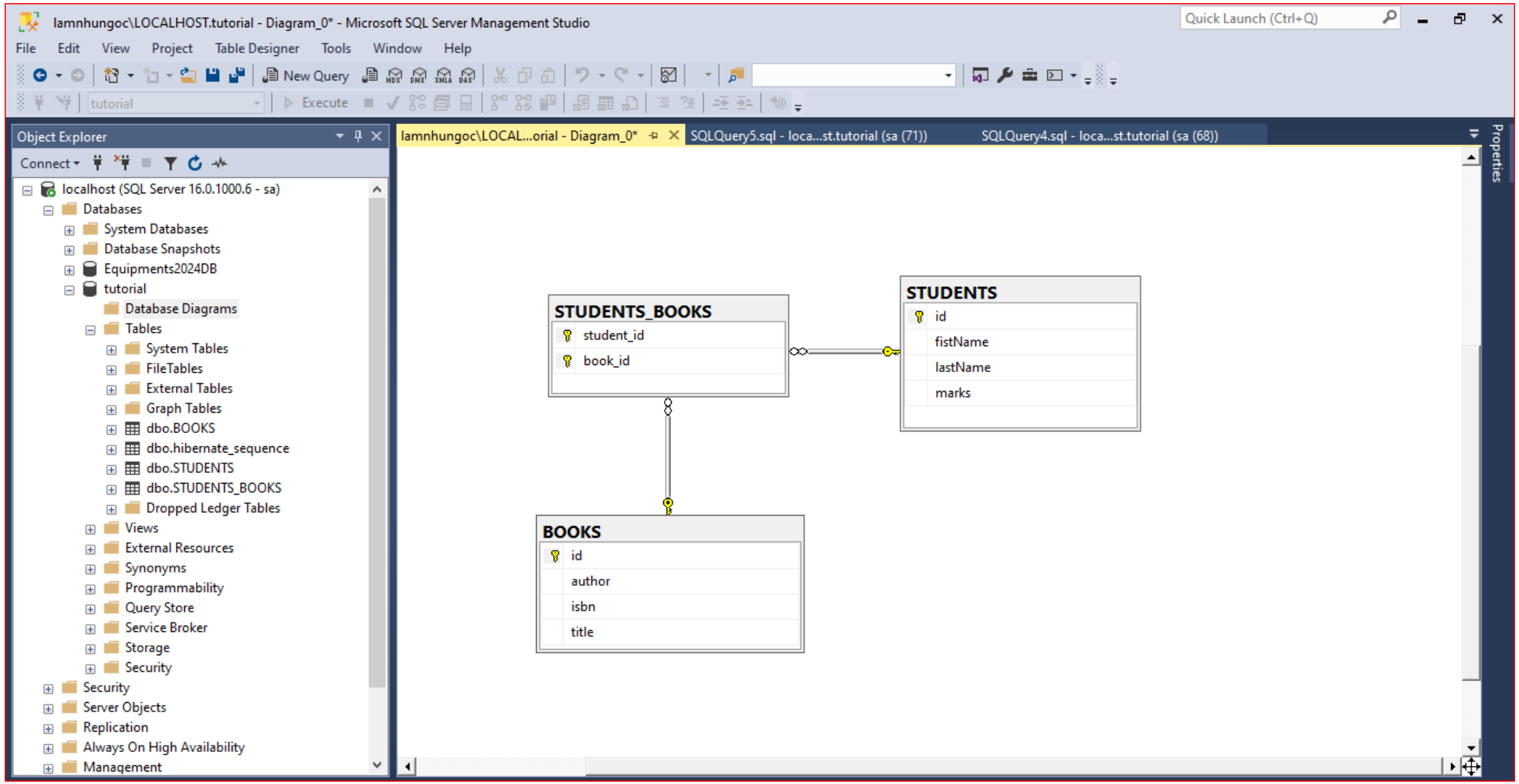
2. Create Students in Pojo's Package



3. Run Program



4. Result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Quick Launch (Ctrl+Q)
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New Query
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Object Explorer
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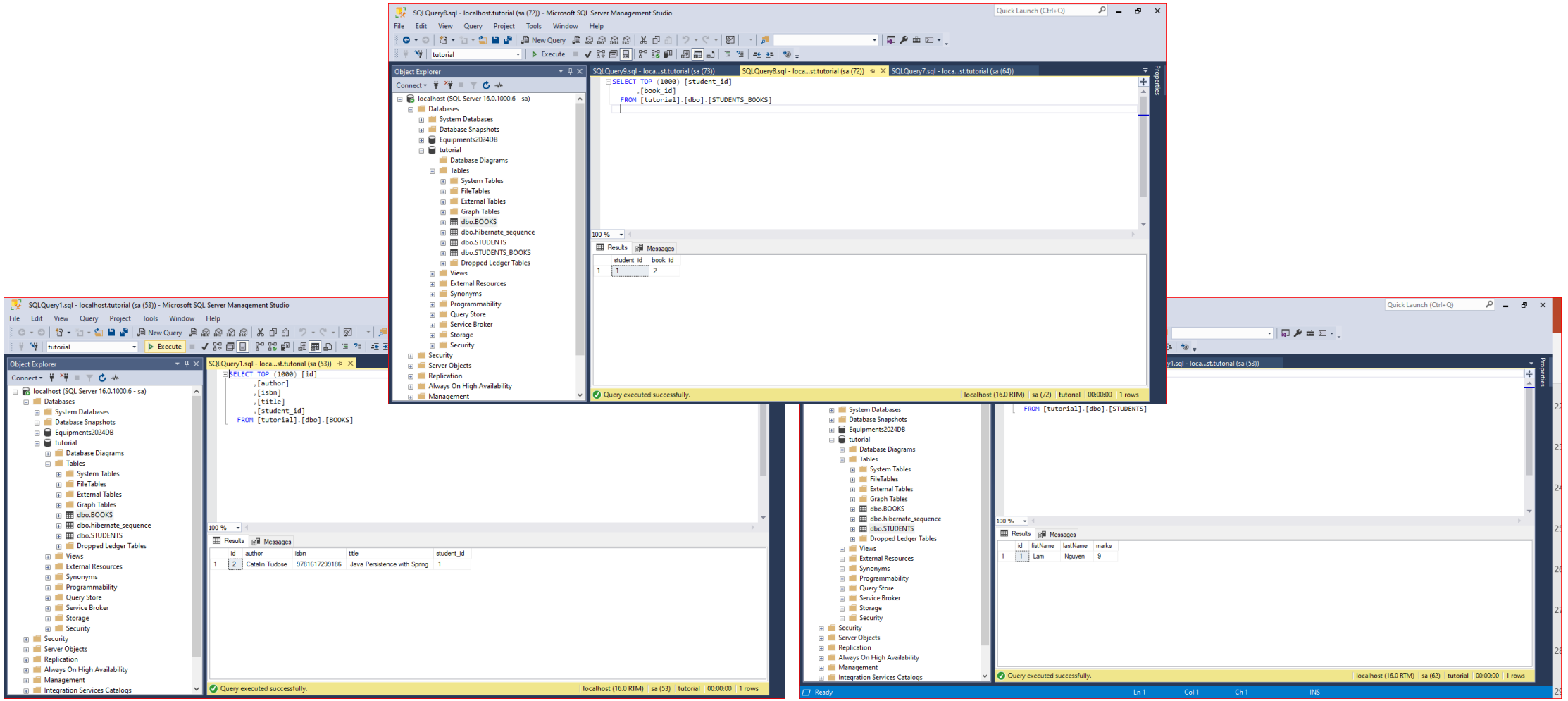
localhost (SQL Server 16.0.1000.6 - sa)
Databases
System Databases
Database Snapshots
Equipments2024DB
tutorial
Database Diagrams
Tables
System Tables
FileTables
External Tables
Graph Tables
dbo.BOOKS
dbo.hibernate_sequence
dbo.STUDENTS
dbo.STUDENTS_BOOKS
Dropped Ledger Tables
Views
External Resources
Synonyms
Programmability
Query Store
Service Broker
Storage
Security
Security
Server Objects
Replication
Always On High Availability
Management
lamnhungoc\LOCAL...orial - Diagram_0*
SQLQuery5.sql - loca...st.tutorial (sa (71))
SQLQuery4.sql - loca...st.tutorial (sa (68))
Properties
STUDENTS_BOOKS
student_id
book_id
STUDENTS
id
fistName
lastName
marks
BOOKS
id
author
isbn
title

5. Result


SQLQuery8.sql - localhost.tutorial (sa (72)) - Microsoft SQL Server Management Studio
SELECT TOP (1000) [student_id]
,[book_id]
FROM [tutorial].[dbo].[STUDENTS_BOOKS]
Query executed successfully.
SQLQuery1.sql - localhost.tutorial (sa (53)) - Microsoft SQL Server Management Studio
SELECT TOP (1000) [id]
,[author]
,[isbn]
,[title]
,[student_id]
FROM [tutorial].[dbo].[BOOKS]
Query executed successfully.
SELECT TOP (1000) [id]
,[fistName]
,[lastName]
,[marks]
FROM [tutorial].[dbo].[STUDENTS]
Query executed successfully.
Ready

Summary

- Concepts were introduced:
  - Overview about Hibernate
  - Architecture Overview new features of Hibernate
  - Explain and demo using Eclipse IDE to create Hibernate Console
  - Create and Run cross-platform Console application with Java connect to MSSQL with Repository Pattern