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Introduction to Spring JDBC

Using JdbcTemplate

Objectives

After completing this lesson, you should be able to

- Explain the problems with traditional JDBC
- Use and configure Spring's **`JdbcTemplate`**
- Execute queries using callbacks to handle result sets
- Handle Exceptions

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Agenda

- Problems with Traditional JDBC
- Spring's **`JdbcTemplate`**
- Lab
- Optional Slides

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Redundant, Error Prone Code in Traditional JDBC code

```
public List<Person> findByLastName(String lastName) {
    List<Person> personList = new ArrayList<>();
    String sql = "select first_name, age from PERSON where last_name=?";

    try (Connection conn = dataSource.getConnection();
           PreparedStatement ps = conn.prepareStatement(sql)) {
        ps.setString(1, lastName);

        try (ResultSet rs = ps.executeQuery()) {
            while (rs.next()) {
                personList.add(new Person(rs.getString("first_name"), ...));
            }
        }
    } catch (SQLException e) {
        /* ??? */
    }

    return personList;
}
```

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Redundant, Error Prone Code in Traditional JDBC code

```
public List<Person> findByLastName(String lastName) {
    List<Person> personList = new ArrayList<>();
    String sql = "select first_name, age from PERSON where last_name=?";

    try (Connection conn = dataSource.getConnection();
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        try (ResultSet rs = ps.executeQuery()) {
            while (rs.next()) {
                personList.add(new Person(rs.getString("first_name"), ...));
            }
        }
    } catch (SQLException e) {
        /* ??? */
    }

    return personList;
}
```

The bold matters - the rest is *boilerplate*

Redundant, Error Prone Code in Traditional JDBC code

```
public List<Person> findByLastName(String lastName) {
    List<Person> personList = new ArrayList<>();
    String sql = "select first_name, age from PERSON where last_name=?";

    try (Connection conn = dataSource.getConnection();
           PreparedStatement ps = conn.prepareStatement(sql)) {
        ps.setString(1, lastName);

        try (ResultSet rs = ps.executeQuery()) {
            while (rs.next()) {
                personList.add(new Person(rs.getString("first_name"), ...));
            }
        }
    } catch (SQLException e) {
        /* ??? */
    }

    return personList;
}
```

How do you handle low-level SQLException?

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Agenda

- Problems with Traditional JDBC
- Spring's **`JdbcTemplate`**
  - **Introduction**
  - Basic Usage
  - Working with result sets
  - Exception handling
- Lab
- Optional Slides

Template Design Pattern

- Widely used and useful pattern
  - http://en.wikipedia.org/wiki/Template_method_pattern
- Define the outline or skeleton of an algorithm
  - Leave the details to specific implementations later
  - Hides away large amounts of *boilerplate* code
- Spring provides many template classes
  - **`JdbcTemplate`**, **`JmsTemplate`**
  - **`RestTemplate`**, **`WebServiceTemplate`** …
  - Most hide low-level resource management

Spring's JdbcTemplate

- Greatly simplifies use of the JDBC API
  - Eliminates repetitive boilerplate code
  - Alleviates common causes of bugs
  - Handles `SQLExceptions` properly
- Without sacrificing power
  - Provides full access to the standard JDBC constructs

"Life is too short to write JDBC!"

- *Rod Johnson co-founder of Spring*

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JdbcTemplate in a Nutshell

```
int count = jdbcTemplate.queryForObject(
   "SELECT COUNT(*) FROM CUSTOMER", Integer.class);
```

- Acquisition of the connection
- Participation in the transaction
- Execution of the statement
- Processing of the result set
- Handling exceptions
- Release of the connection

All handled by Spring

Using Callbacks

```
List<Customer> results = jdbcTemplate.query(someSql,
  new RowMapper<Customer>() {
    public Customer mapRow(ResultSet rs, int row) throws SQLException {
       // map the current row to a Customer object
    }
  });
```

```
class JdbcTemplate {
   public List<Customer> query(String sql, RowMapper rowMapper) {
      try {
         // acquire connection
         // prepare statement
         // execute statement
         // for each row in the result set
         results.add(rowMapper.mapRow(rs, rowNumber));
         return results;
      } catch (SQLException e) {
         // convert to root cause exception
      }  finally { /* release connection */ }
}
```

Callback method

Creating a JdbcTemplate

- Requires a **`DataSource`**

```
JdbcTemplate template = new JdbcTemplate(dataSource);
```

- Create a template once and re-use it
  - Do not create one for each thread
  - Thread safe after construction
- Uses
  - *Anytime* JDBC is needed
  - In utility or test code
  - To clean up messy legacy code

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Implementing a JDBC-based Repository

```
public class JdbcCustomerRepository implements CustomerRepository {

    private JdbcTemplate jdbcTemplate;

    public JdbcCustomerRepository(DataSource dataSource) {
        this.jdbcTemplate = new JdbcTemplate(dataSource);
    }

    public int getCustomerCount() {
        String sql = "select count(*) from customer";
        return jdbcTemplate.queryForObject(sql, Integer.class);
    }
}
```

No try / catch needed
(unchecked exceptions)

Querying with JdbcTemplate

- `JdbcTemplate` can query for
  - Simple types (int, long, String, Date, ...)
  - Generic Maps
  - Domain Objects

Query for Simple Java Types

- Query with no bind variables

```
public Date getOldest() {
    String sql = "select min(dob) from PERSON";
    return jdbcTemplate.queryForObject(sql, Date.class);
}

public long getPersonCount() {
    String sql = "select count(*) from PERSON";
    return jdbcTemplate.queryForObject(sql, Long.class);
}
```

Older alternatives, **`queryForInt()`**, **`queryForLong()`**, deprecated and removed since Spring 4.2

Query With Bind Variables

- Can query using bind variables – ?
  - Note the use of a variable argument list

```
private JdbcTemplate jdbcTemplate;

public int getCountOfNationalsOver(Nationality nationality, int age) {
    String sql = "select count(*) from PERSON " +
                 "where age > ? and nationality = ?";

    return jdbcTemplate.queryForObject
                         (sql, Integer.class, age, nationality.toString());
}
```

Bind to first ?

Bind to second ?

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Database Writes (1)

- Inserting a new row
  - Returns number of rows modified

```
public int insertPerson(Person person) {
   return jdbcTemplate.update(
      “insert into PERSON (first_name, last_name, age)” +
      “values (?, ?, ?)”,
      person.getFirstName(),
      person.getLastName(),
      person.getAge());
}
```

Database Writes (2)

- Updating an existing row

```
public int updateAge(Person person) {
    return jdbcTemplate.update(
            “update PERSON set age=? where id=?”,
            person.getAge(),
            person.getId());
}
```

Any non-SELECT SQL is run using update()

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Generic Queries

- `JdbcTemplate` can return each row of a `ResultSet` as a `Map`
  - When expecting a single row
    - Use queryForMap(..)
  - When expecting multiple rows
    - Use queryForList(..)
- Useful for *ad hoc* reporting, testing use cases
  - The data fetched *does not need* mapping to a Java object

ad hoc – created or done for a particular purpose as necessary
– sometimes called “window-on-data” queries

Querying for Generic Maps (1)

- Query for a single row

```
public Map<String,Object> getPersonInfo(int id) {
    String sql = "select * from PERSON where id=?";
    return jdbcTemplate.queryForMap(sql, id);
}
```

- Returns

Map { ID=1, FIRST_NAME="John", LAST_NAME="Doe" }

A Map of [Column Name | Field Value] pairs

Querying for Generic Maps (2)

- Query for multiple rows

```
public List<Map<String,Object>> getAllPersonInfo() {
    String sql = "select * from PERSON";
    return jdbcTemplate.queryForList(sql);
}
```

- Returns

A List of Maps of [Column Name | Field Value] pairs

```
List {
 0 - Map { ID=1, FIRST_NAME="John", LAST_NAME="Doe" }
 1 - Map { ID=2, FIRST_NAME="Jane", LAST_NAME="Doe" }
 2 - Map { ID=3, FIRST_NAME="Junior”, LAST_NAME="Doe" }
}
```

Domain Object Queries

- Often it is useful to map relational data into domain objects
  - e.g. a **`ResultSet`** to an **`Account`**

- Spring's **`JdbcTemplate`** supports this using a callback approach

- You may prefer to use ORM for this
  - Need to decide between **`JdbcTemplate`** queries and JPA (or similar) mappings
  - Some tables may be too hard to map with JPA

RowMapper for mapping a row

- Spring provides a **`RowMapper`** interface for mapping a single row of a **`ResultSet`** to an object
  - Can be used for both single and multiple row queries
  - Parameterized to define its return-type

```
public interface RowMapper<T> {
   T mapRow(ResultSet rs, int rowNum)
      throws SQLException;
}
```

Querying for Domain Objects (1)

- Query for single row with **`JdbcTemplate`**

Returns a Domain object

Define RowMapper using *Lambda*

```
public Person getPerson(int id) {
  return jdbcTemplate.queryForObject(
    "select first_name, last_name from PERSON where id=?",
    (rs, rowNum) -> new Person(rs.getString("first_name"),
                               rs.getString("last_name"))
    ,id);
```

Alternative implementation using an explicit **`RowMapper`** subclass is shown at the end of this section.

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Querying for Domain Objects (2)

- Query for multiple rows

Returns a List of Domain objects

Define RowMapper using *Lambda*

```
public List<Person> getAllPersons() {
    return jdbcTemplate.query(
        "select first_name, last_name from PERSON",
        (rs, rowNum) -> new Person(rs.getString("first_name"),
                                   rs.getString("last_name"))
        );
```

ResultSetExtractor

- Spring provides a **`ResultSetExtractor`** interface for processing an entire **`ResultSet`** at once
  - *You* are responsible for iterating the **`ResultSet`**
  - *Example:* mapping entire **`ResultSet`** to a *single* object

```
public interface ResultSetExtractor<T> {
   T extractData(ResultSet rs)  throws SQLException,
                                       DataAccessException;
}
```

You may need this for the lab!

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Using a ResultSetExtractor

Using a *lambda*

```
public class JdbcOrderRepository {
    public Order findByConfirmationNumber(String number) {
        // Execute an outer join between order and item tables
        return jdbcTemplate.query(
            "select...from order o, item i...conf_id = ?",
            (ResultSetExtractor<Order>)(rs) -> {
                Order order = null;
                while (rs.next()) {
                    if (order == null)
                        order = new Order(rs.getLong("ID"), rs.getString("NAME"), ...);
                    order.addItem(mapItem(rs));
                }
                return order;
            },
            number);
    }
}
```

Cast needed

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Summary of Callback Interfaces

- **`RowMapper`**
  - Best choice when *each* row of a **`ResultSet`** maps to a domain object
- **`ResultSetExtractor`**
  - Best choice when *multiple* rows of a **`ResultSet`** map to a *single* object
- **`RowCallbackHandler`**
  - Yet another handler that writes to alternative destinations

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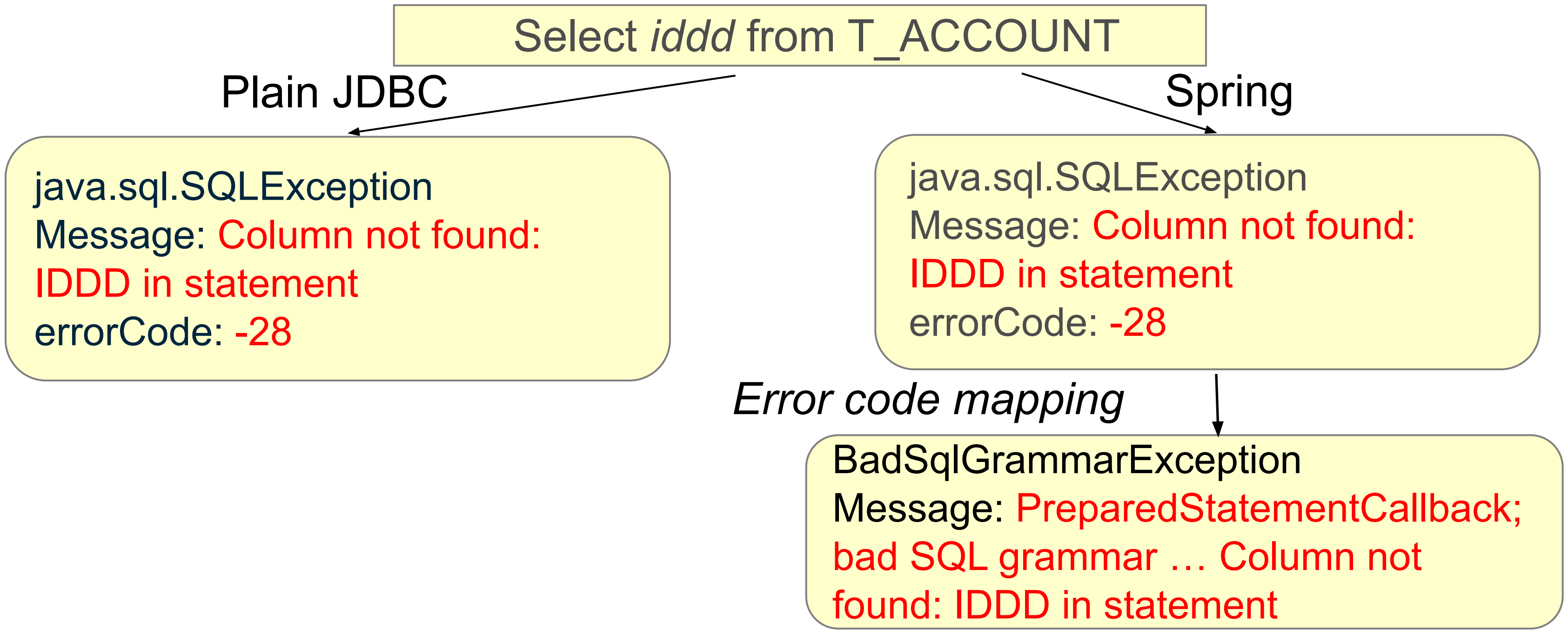
Exception Handling and Spring

- Checked Exceptions
  - Force developers to handle errors
    - But if you can't handle it, must declare it
  - Bad: intermediate methods must declare exception(s) from *all* methods below
    - A form of tight-coupling
- Unchecked Exceptions
  - Can throw up the call hierarchy to the best place to handle it
  - Good: Methods in between don't know about it
    - Better in an Enterprise Application
  - **Spring always throws Runtime (unchecked) Exceptions**

Data Access Exceptions

- `SQLException`
  - Too general – one exception for every database error
  - Calling class 'knows' you are using JDBC
  - Tight coupling
- Spring provides `DataAccessException` hierarchy
  - Hides whether you are using JPA, Hibernate, JDBC …
  - Actually a hierarchy of sub-exceptions
    - Not just one exception for everything
  - Consistent across all supported Data Access technologies
  - Unchecked

Example: *BadSqlGrammarException*



Select *iddd* from T_ACCOUNT

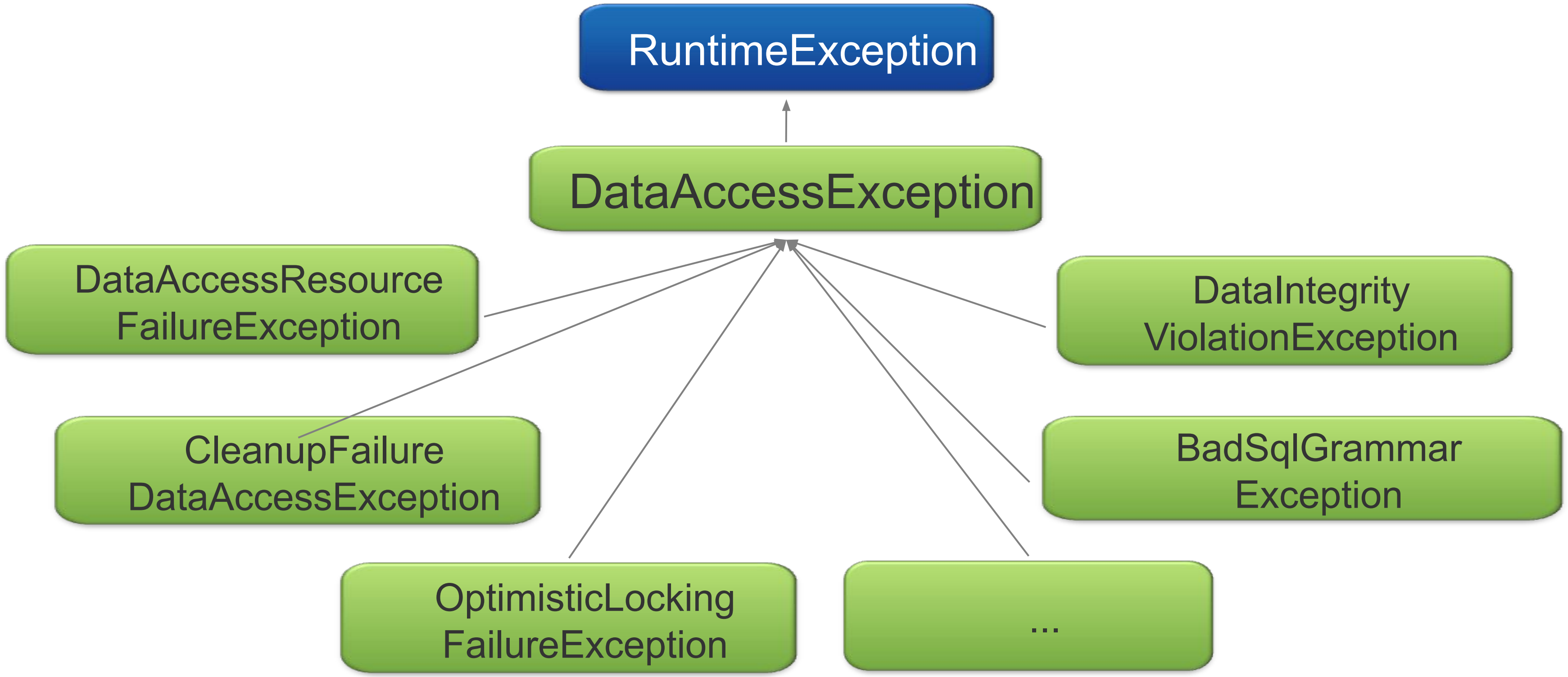
java.sql.SQLException
Message: Column not found:
IDDD in statement
errorCode: -28

java.sql.SQLException
Message: Column not found:
IDDD in statement
errorCode: -28

BadSqlGrammarException
Message: PreparedStatementCallback;
bad SQL grammar … Column not
found: IDDD in statement

https://github.com/spring-projects/spring-framework/blob/master/spring-jdbc/src/main/resources/org/springframework/jdbc/support/sql-error-codes.xml

Spring Data Access Exceptions


RuntimeException
DataAccessException
DataAccessResource FailureException
DataIntegrity ViolationException
CleanupFailure DataAccessException
BadSqlGrammar Exception
OptimisticLocking FailureException
...

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Summary

- JDBC is useful
  - But using JDBC API directly is tedious and error-prone
- **`JdbcTemplate`** simplifies data access and enforces consistency
  - DRY principle hides most of the JDBC
  - Many options for reading data
- **`SQLExceptions`** typically cannot be handled where thrown
  - Should not be *checked* Exceptions
  - Spring provides ***`DataAccessException`*** instead

Lab: JDBC Simplification with JdbcTemplate

Lab project:
26-jdbc

Anticipated Lab time:
45 Minutes

Optional Topics: Callbacks without Lambdas

Querying for Domain Objects (1)

- Query for single row with JdbcTemplate

```
public Person getPerson(int id) {
    return jdbcTemplate.queryForObject(
        "select first_name, last_name from PERSON where id=?",
        new PersonMapper(), id);
}
```

No need to cast

Maps rows to Person objects

Parameterizes return type

```
class PersonMapper implements RowMapper<Person> {
    public Person mapRow(ResultSet rs, int rowNum) throws SQLException {
        return new Person(rs.getString("first_name"),
                          rs.getString("last_name"));
    }
}
```

Querying for Domain Objects (2)

- Query for multiple rows

No need to cast

```
public List<Person> getAllPersons() {
    return jdbcTemplate.query(
            "select first_name, last_name from PERSON",
            new PersonMapper());
```

Same row mapper can be used

```
class PersonMapper implements RowMapper<Person> {
    public Person mapRow(ResultSet rs, int rowNum) throws SQLException {
        return new Person(rs.getString("first_name"),
                          rs.getString("last_name"));
    }
}
```

ResultSetExtractor *without* a Lambda

```
public class JdbcOrderRepository {
    public Order findByConfirmationNumber(String number) {
        // execute an outer join between order and item tables
        return jdbcTemplate.query(
                "select...from order o, item i...conf_id = ?",
                new OrderExtractor(), number);
    }
}
```

```
class OrderExtractor implements ResultSetExtractor<Order> {
    public Order extractData(ResultSet rs) throws SQLException {
       Order order = null;
        while (rs.next()) {
            if (order == null) {
                order = new Order(rs.getLong("ID"), rs.getString("NAME"), ...);
            }
            order.addItem(mapItem(rs));
        }
        return order;
    }
}
```

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