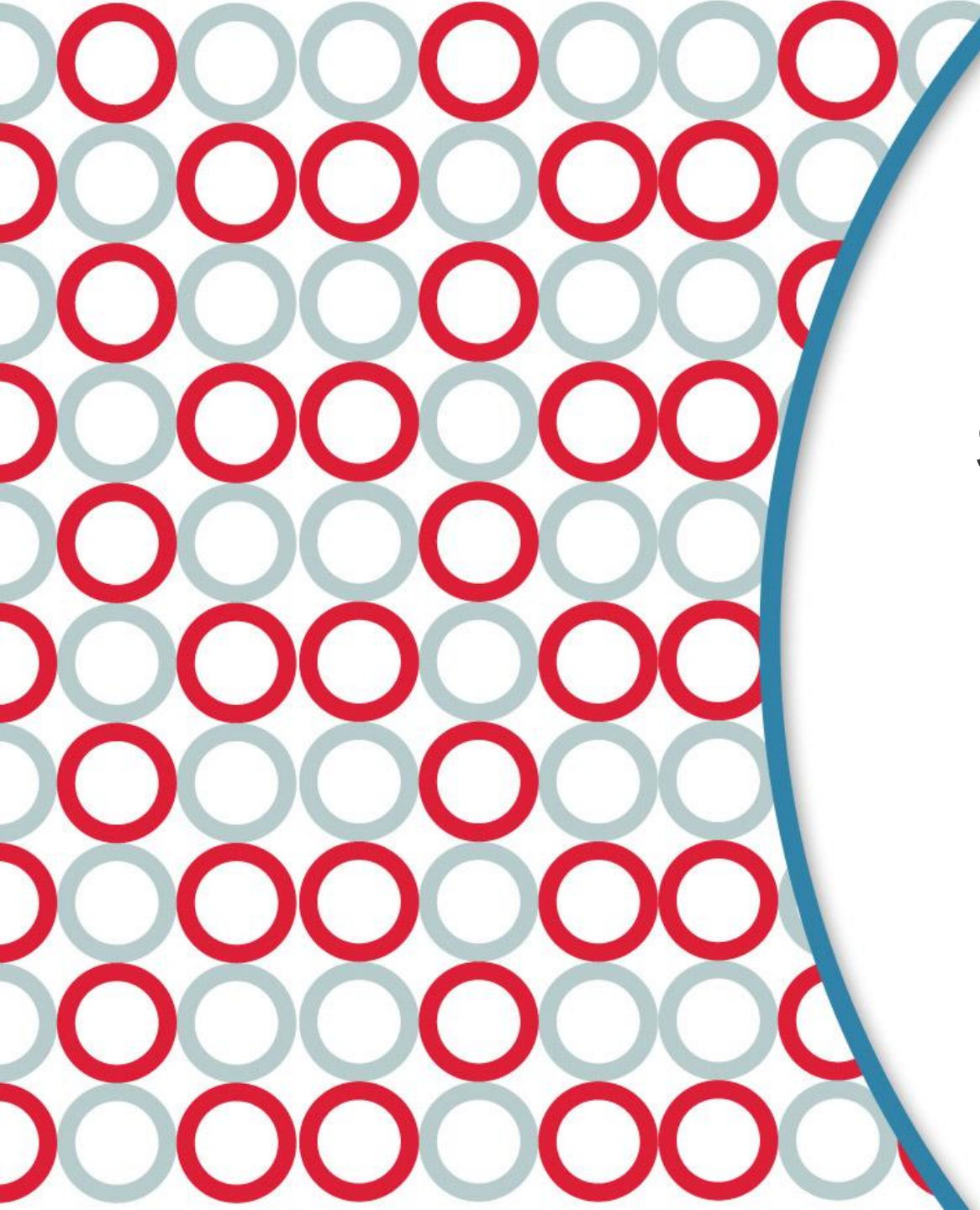

April 2024, IPT Course
Introduction to Spring

Spring JDBC Support. ORM. Transactions Hibernate

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Agenda for This Session

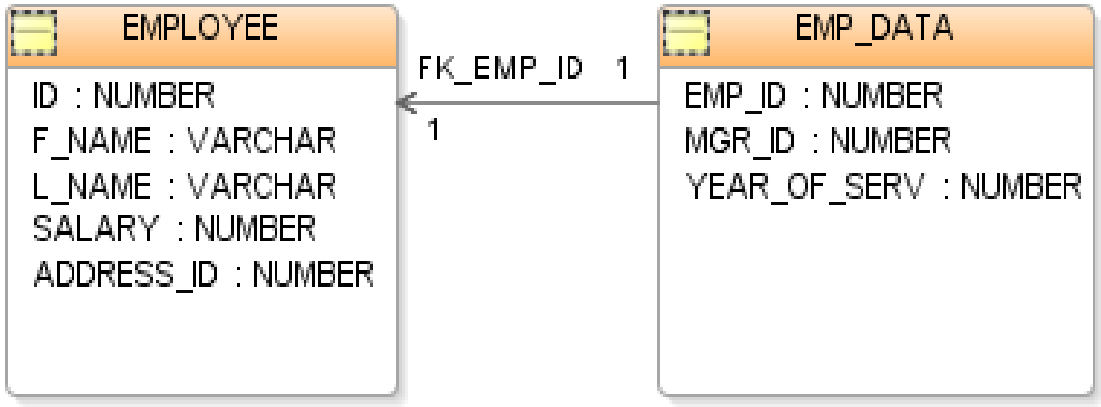
- DAO pattern.
- Spring JDBC Infrastructure
- Database Connections and DataSources
- Embedded database support
- Exception handling. JdbcTemplate class.
- Retrieving nested entities with ResultSetExtractor.
- Spring classes modelling main JDBC operations.
- Inserting data and retrieving the generated key.
- Spring Data project - JDBC extensions.
- Spring Boot starter JDBC.

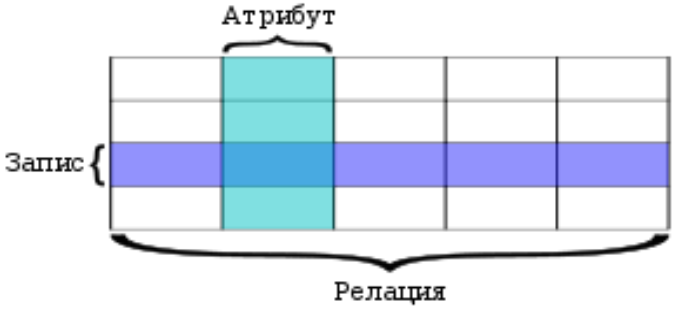
Where to Find the Demo Code?

Introduction to Spring 5 demos and examples are available @ GitHub:

https://github.com/iproduct/course-spring5

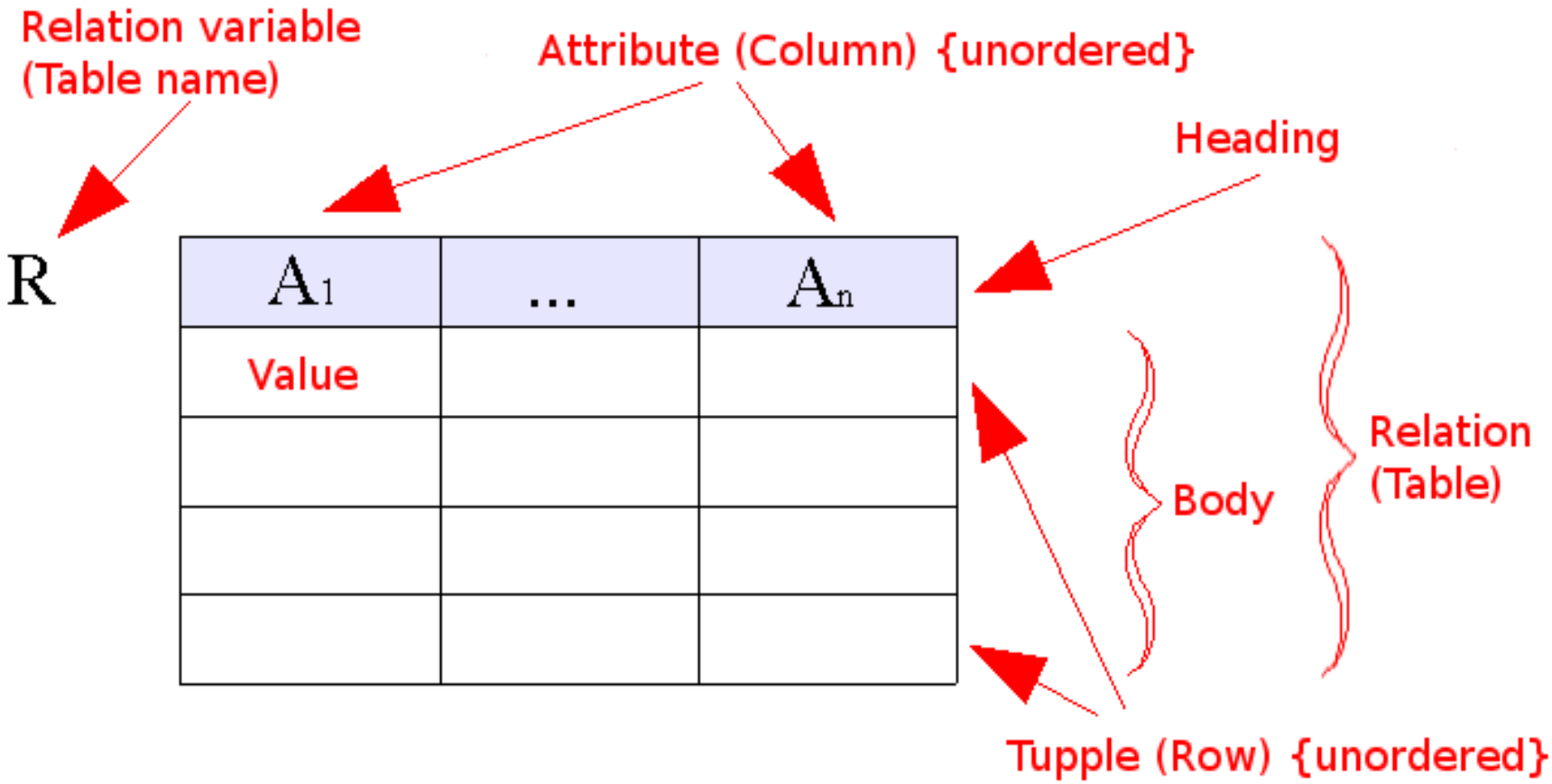
Relational Model





- релация, релационна схема (relation) ↔ таблица (table),
- запис, кортеж (tuple) ↔ ред (row)
- атрибут, поле (attribute) ↔ стълб, колона (column)

Relational Model



Views. Domains. Constraints

- **Def:** Relations which store primary data are called **base relations or tables**. Other relations, which are derived from primary relations are **queries** and **views**.

- **Def: Domain** in database is a set of allowed values for a given attribute in a relation – an exisiting costraint about valid the type of values for given attribute.

- **Def: Constraints** allow more flexible specification of values that are valid for given attribute – e.g. from 1 to 10.

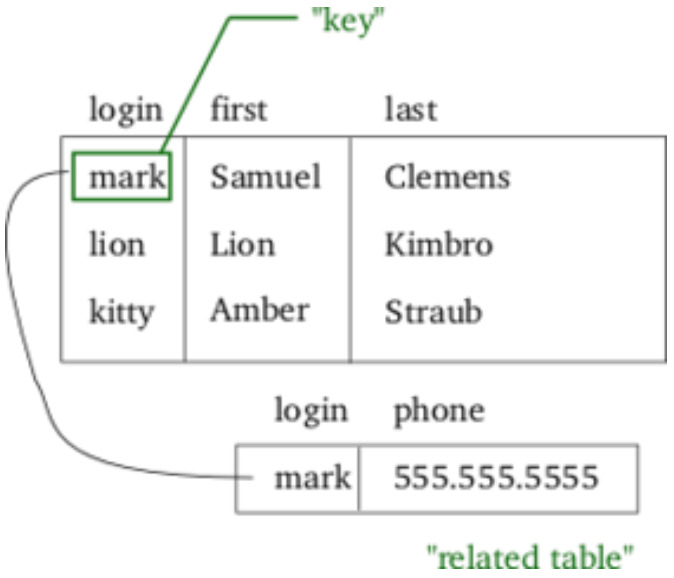
Keys

❖**Key** consists of one or more attributes, sush as:

1) relation has no two records with the same values for these attributes

2) there is no proper subset of these attributes with the same property

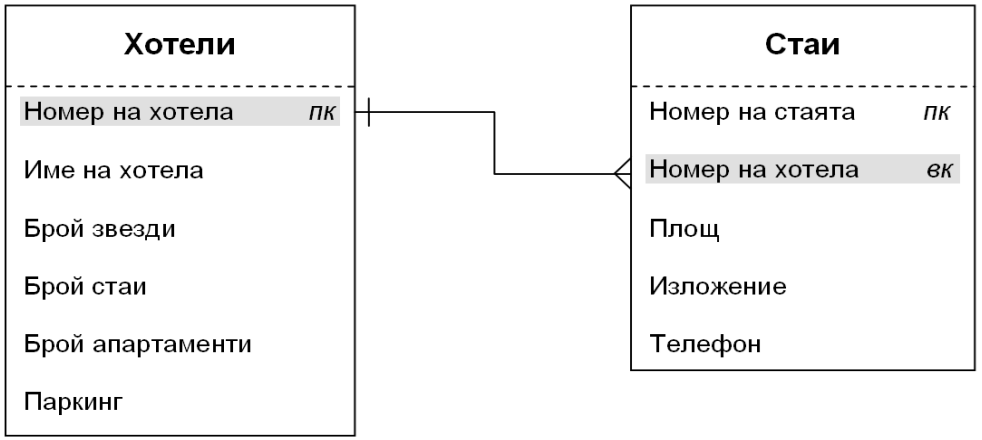
❖**Primary Key** is an attribute (less frequently a group of attributes), which uniquely identifies each record (tupple) in the relation

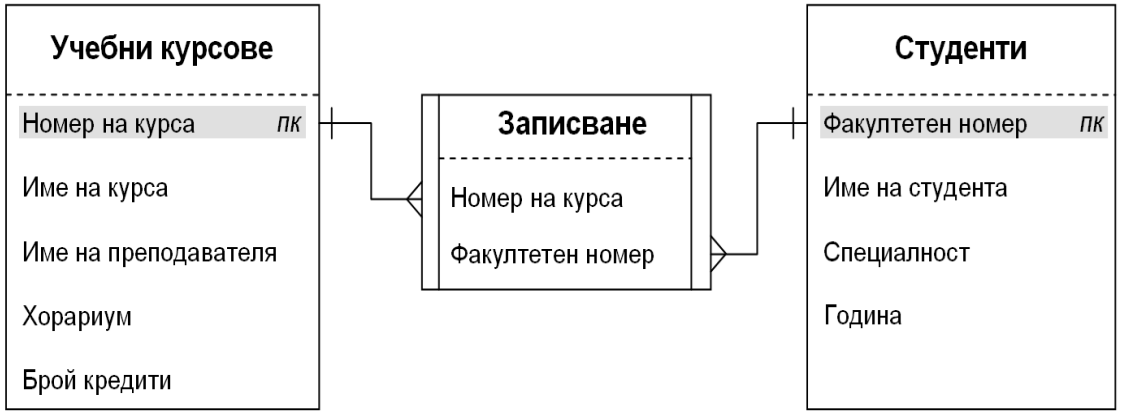


❖**Foreign key** is necessary when there exists a relation between two tables

Table Relations. Cardinality

- Relationship is a dependency existing between two tables, when the records from first table can be connected somehow with records from second one.
- Cardinality:
- One to one (1:1),
- One to many (1:N),
- Many to many (M:N)





Spring Data Access Objects (DAO)

❖**Data Access Object (DAO)** – simplifies work with different data access technologies like **JDBC**, **Hibernate** or **JPA** in a consistent way.

❖Consistent exception hierarchy - **RuntimeExceptions**

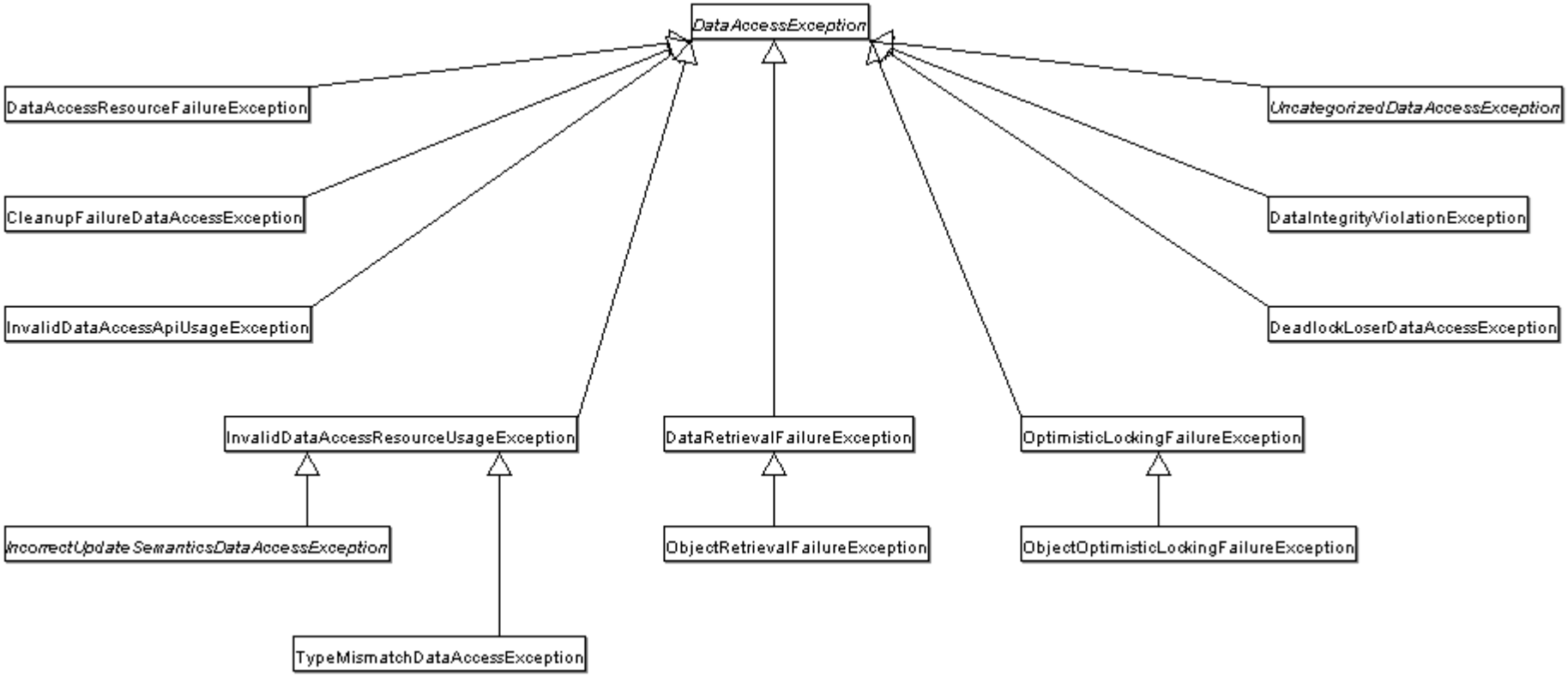
❖Annotations used for configuring **DAO** or **Repository** classes – with automatic exception translation:

```
import org.springframework.stereotype.Repository;

@Repository
public class SomeMovieFinder implements MovieFinder {
    // ...
}
```


Source: https://docs.spring.io/spring-framework/docs/

DAO Exception Hierarchy



Source: https://docs.spring.io/spring-framework/docs/

DAO Repository - JDBC

```
import javax.sql.DataSource;

@Repository
public class JdbcMovieFinder implements MovieFinder {

    private JdbcTemplate jdbcTemplate;

    @Autowired
    public void init(DataSource dataSource) {
        this.jdbcTemplate = new JdbcTemplate(dataSource);
    }

    // ...

}
```


Source: https://docs.spring.io/spring-framework/docs/

DAO Repository - Hibernate

```
import org.hibernate.SessionFactory;
import

org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Repository;

@Repository
public class HibernateMovieFinder implements MovieFinder {

    private SessionFactory sessionFactory;

    @Autowired
    public void setSessionFactory(SessionFactory
sessionFactory) {
        this.sessionFactory = sessionFactory;
    }

    // ...
}
```


Source: https://docs.spring.io/spring-framework/docs/

DAO Repository - JPA

```
import org.springframework.stereotype.Repository;

import javax.persistence.EntityManager;
import javax.persistence.PersistenceContext;

@Repository
public class JpaMovieFinder implements MovieFinder {

    @PersistenceContext
    private EntityManager entityManager;

    // ...

}
```


Source: https://docs.spring.io/spring-framework/docs/

Spring JDBC

Action	Spring	You
Define connection parameters.		X
Open the connection.	X	
Specify the SQL statement.		X
Declare parameters and provide parameter values		X
Prepare and execute the statement.	X	
Set up the loop to iterate through the results (if any).	X	
Do the work for each iteration.		X
Process any exception.	X	
Handle transactions.	X	
Close the connection, statement and resultset.	X	

Source: https://docs.spring.io/spring-framework/docs/

JDBC DB Access Alternatives

- JdbcTemplate - the “classic” Spring JDBC approach and the most popular - "lowest level", all others use a JdbcTemplate
- NamedParameterJdbcTemplate – wraps a JdbcTemplate to provide named parameters instead of the "?" placeholders
- SimpleJdbcInsert and SimpleJdbcCall uses DB metadata, you only need to provide the name of the table or procedure and provide a map of parameters matching column names.
- RDBMS Objects – include MappingSqlQuery, SqlUpdate and StoredProcedure, you create reusable and thread-safe objects during initialization, like JDO Query, wherein you define your query string, declare parameters, and compile the query. Then you can execute methods multiple times.

Source: https://docs.spring.io/spring-framework/docs/

JDBC Repository Methods - I

```
@Override
public Collection<Article> findAll() {
    List<Article> articles = this.jdbcTemplate
            .query("select * from articles", new
ArticleMapper());
    log.info("Articles loaded: {}", articles.size());
    return articles;
}

@Override
public Article find(long  id) {
    Article article = this.jdbcTemplate.queryForObject(
            "select * from articles where id = ?",
            new Object[]{id}, new ArticleMapper());
    log.info("Article found: {}", article);
    return article;
}
```


Source: https://docs.spring.io/spring-framework/docs/

JDBC Repository Methods - II

```
@Override
public Article create(Article article) {
    KeyHolder keyHolder = new GeneratedKeyHolder();
    jdbcTemplate.update(new PreparedStatementCreator() {
       public PreparedStatement createPreparedStatement
             (Connection connection) throws SQLException {
          PreparedStatement ps = connection
             .prepareStatement(INSERT_SQL, new String[] {"id"});
          ps.setString(1, article.getTitle());
          ps.setString(2, article.getContent());
          ps.setTimestamp(3, new Timestamp(
                          article.getCreatedDate().getTime()));
          ps.setString(4, article.getPictureUrl());
          return ps;
       }
    }, keyHolder);
    article.setId(keyHolder.getKey().longValue());
    log.info("Article created: {}", article);
    return article;
}
```


Source: https://docs.spring.io/spring-framework/docs/

JDBC Repository Methods - III

```
@Override
public Article update(Article article) {
    int count = this.jdbcTemplate.update(
"update articles set (title, content, created_date, picture_url)
                VALUES (?,?, ?, ?) where id = ?",
              article.getTitle(), article.getContent(),
              article.getCreatedDate(),
              article.getPictureUrl(), article.getId());
    log.info("Article updated: {}", article);
    return article;
}

@Override
public boolean remove(long articleId) {
    int count = this.jdbcTemplate.update(
              "delete from articles where id = ?",
              Long.valueOf(articleId));
    return count > 0;
}
```


Source: https://docs.spring.io/spring-framework/docs/

JDBC DataSource - I

```
@Configuration
@ComponentScan({"org.iproduct.spring.webmvc.service",
"org.iproduct.spring.webmvc.dao"})
    @PropertySource("classpath:jdbc.properties")
    public class SpringRootConfig {

        @Value("${jdbc.driverClassName:org.postgresql.Driver}")
        private String driverClassname;

       @Value("${jdbc.url:jdbc:postgresql://localhost/articles}")
        private String url;

        @Value("${jdbc.username:postgres}")
        private String username;

        @Value("${jdbc.password:postgres}")
        private String password;
        ( - continues on next slide -)
```


Source: https://docs.spring.io/spring-framework/docs/

JDBC DataSource - II

```
@Bean
DataSource getDataSource(){
    DriverManagerDataSource dataSource =
                            new DriverManagerDataSource();
     //PostgreSQL database we are using
     dataSource.setDriverClassName(driverClassname);
     dataSource.setUrl(url);//change url
     dataSource.setUsername(username);//change username
     dataSource.setPassword(password);//change pwd

     //H2 database
     /*
     dataSource.setDriverClassName("org.h2.Driver");
     dataSource.setUrl("jdbc:h2:tcp://localhost/~/test");
     dataSource.setUsername("sa");
     dataSource.setPassword("");*/
     return dataSource;
}
}
```


Source: https://docs.spring.io/spring-framework/docs/

Hibernate DAO

```
import org.hibernate.SessionFactory;
import

org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Repository;

@Repository
public class HibernateMovieFinder implements MovieFinder {

    private SessionFactory sessionFactory;

    @Autowired
    public void setSessionFactory(
                SessionFactory sessionFactory) {
        this.sessionFactory = sessionFactory;
    }
    // ...
}
```


Source: https://docs.spring.io/spring-framework/docs/

Web Initializer – XML Root Config

```
public class ArticlesWebInitializer extends
        AbstractAnnotationConfigDispatcherServletInitializer {
    @Override
    protected WebApplicationContext
                                createRootApplicationContext() {
        return new XmlWebApplicationContext();
    }

    @Override
    protected Class<?>[] getRootConfigClasses() {
        return new Class[0];
    }

    @Override
    protected Class<?>[] getServletConfigClasses() {
        return new Class<?>[] { SpringWebConfig.class };
    }
}
```


Source: https://docs.spring.io/spring-framework/docs/

WEB-INF/applicationContext.xml -I

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:context="http://www.springframework.org/schema/context"
       xmlns:aop="http://www.springframework.org/schema/aop"
       xmlns:tx="http://www.springframework.org/schema/tx"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans.xsd
        http://www.springframework.org/schema/context
        http://www.springframework.org/schema/context/spring-context.xsd
        http://www.springframework.org/schema/tx
        http://www.springframework.org/schema/tx/spring-tx.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop.xsd">

    <context:property-placeholder location="classpath:jdbc.properties" />

    <context:component-scan base-package="org.iproduct.spring.webmvc.dao,
         org.iproduct.spring.webmvc.service"/>

    <context:annotation-config />
```


Source: https://docs.spring.io/spring-framework/docs/

WEB-INF/applicationContext.xml -II

```
<bean id="dataSource" class="org.apache.commons.dbcp2.BasicDataSource"
      destroy-method="close">
    <property name="driverClassName" value="${jdbc.driverClassName}" />
    <property name="url" value="${jdbc.url}" />
    <property name="username" value="${jdbc.username}" />
    <property name="password" value="${jdbc.password}" />
</bean>

<bean id="sessionFactory"
      class="org.springframework.orm.hibernate5.LocalSessionFactoryBean">
    <property name="dataSource" ref="dataSource"/>
    <property name="mappingResources">
        <list><value>article.hbm.xml</value></list>
    </property>
    <property name="hibernateProperties">
        <value>
            hibernate.dialect=org.hibernate.dialect.HSQLDialect
            hibernate.hbm2ddl.auto=update
        </value>
    </property>
</bean>
```


Source: https://docs.spring.io/spring-framework/docs/

WEB-INF/applicationContext.xml III

```
    <bean id="transactionManager"
       class="org.springframework.orm.hibernate5.HibernateTransactionManager">
       <property name="sessionFactory" ref="sessionFactory"/>
    </bean>

    <tx:annotation-driven/>

</beans>
```


Source: https://docs.spring.io/spring-framework/docs/

Hibernate Mapping: article.hbm.xml

```
<hibernate-mapping>
    <class name="org.iproduct.spring.webmvc.model.Article" table="ARTICLES">

        <meta attribute="class-description">
            This class contains the articles details.
        </meta>

        <id name="id" type="long" column="id">
            <generator class="identity"/>
        </id>

        <property name="title" column="title" type="string"/>
        <property name="content" column="content" type="string"/>
        <property name="createdDate" column="created_date" type="timestamp"/>
        <property name="pictureUrl" column="picture_url" type="string"/>

    </class>
</hibernate-mapping>
```


Source: https://docs.spring.io/spring-framework/docs/

ArticlesDaoHibernate Class - I

```
@Repository
@Transactional
public class ArticleDaoHibernate implements ArticleDao {

    private SessionFactory sessionFactory;

    @Autowired
    public void setSessionFactory(SessionFactory sessionFactory) {
        this.sessionFactory = sessionFactory;
    }

    @Override
    public Collection<Article> findAll() {
        return this.sessionFactory.getCurrentSession()
          .createQuery("select article from Article article", Article.class)
          .list();
    }
    @Override
    public Article find(long id) {
        return this.sessionFactory.getCurrentSession()
          .byId(Article.class).load(id);
    }
```


Source: https://docs.spring.io/spring-framework/docs/

ArticlesDaoHibernate Class - II

```
@Override
public Article create(Article article) {
    this.sessionFactory.getCurrentSession()
            .persist(article);
    return article;
}
@Override
public Article update(Article article) {
    Article toBeDeleted = find(article.getId());
    if (toBeDeleted == null) {
        throw new EntityNotExistException("Article "+article.getId()+" not exist.");
    }
    return (Article) this.sessionFactory.getCurrentSession()
        .merge(article);
}
@Override
public Article remove(long articleId) {
    Article toBeDeleted = find(articleId);
    if (toBeDeleted == null) {
       throw new EntityNotExistException("Article "+article.getId()+" not exist.");
    }
    this.sessionFactory.getCurrentSession()
        .delete(toBeDeleted);
    return toBeDeleted;
}}
```


Source: https://docs.spring.io/spring-framework/docs/

Transactions and Concurrency

- **Transaction** = Commits as **Business Event**
- **ACID rules:**
- **Atomicity** – the whole transaction is completed (commit) or no part is completed at all (rollback).
- **Consistency** – transaction should presetve existing integrity constraints
- **Isolation** – two uncompleted transactions can not interact
- **Durability** – successfully completed transactions can not be rolled back

Addvantages of Spring Transactions

- Consistent programming model across different transaction APIs such as Java Transaction API (JTA), JDBC, Hibernate, and Java Persistence API (JPA).
- Support for declarative transaction management.
- Simpler API for programmatic transaction management than complex transaction APIs such as JTA.
- Excellent integration with Spring's data access abstractions.

Source: https://docs.spring.io/spring-framework/docs/

Spring Transaction Management

- Global transactions – enable you to work with multiple transactional resources, typically relational databases and message queues (JTA UserTransaction, JNDI lookup).
- Local transactions – resource-specific, such as a transaction associated with a JDBC connection, but cannot work across multiple transactional resources.
- Spring Framework's transactions – consistent programming model in any environment, write code once, and it can use different transaction management strategies in different environments – both declarative and programmatic transaction management (Spring Framework transaction abstraction).

Source: https://docs.spring.io/spring-framework/docs/

Spring Transaction Abstraction

```
public interface PlatformTransactionManager {

    TransactionStatus getTransaction(TransactionDefinition definition)
                        throws TransactionException;

    void commit(TransactionStatus status) throws TransactionException;

    void rollback(TransactionStatus status) throws TransactionException;
}
```

- TransactionDefinition:
  - Propagation – what to do when a transactional method is executed when a transaction context already exists)
  - Isolation – degree to which this transaction is isolated from the work of other transactions (e.g. can this transaction see uncommitted writes from other transactions?)
  - Timeout – how long run before timing out and being rolled back
  - Read-only status: used when you read but not modify data

Source: https://docs.spring.io/spring-framework/docs/

Transaction Isolation Levels

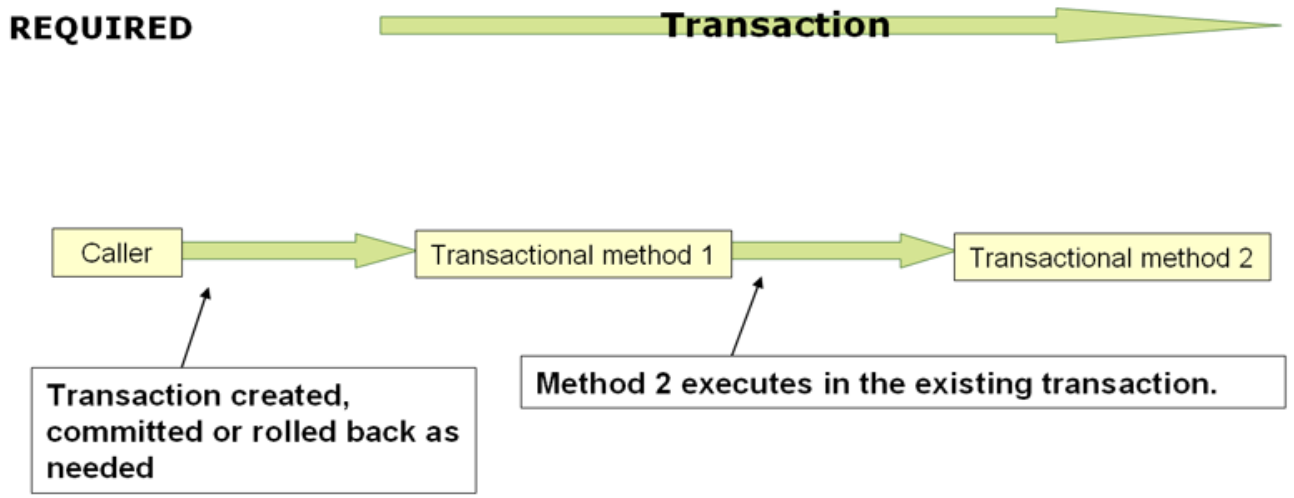
- DEFAULT - use the default isolation level of the underlying datastore
- READ_UNCOMMITTED – dirty reads, non-repeatable reads and phantom reads can occur
- READ_COMMITTED – prevents dirty reads; non-repeatable reads and phantom reads can occur
- REPEATABLE_READ – prevents dirty reads and non-repeatable reads; phantom reads can occur
- SERIALIZABLE – prevents dirty reads, non-repeatable reads and phantom reads

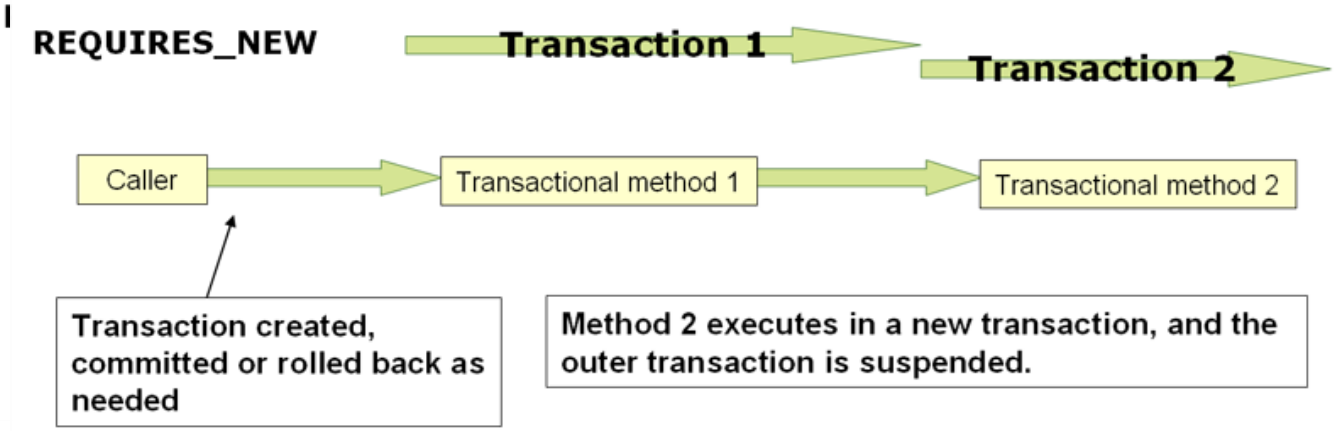
Source: https://docs.spring.io/spring-framework/docs/

Transactions Propagation

- SUPPORTS – supports transaction if exisiting, executes non-transactionally if not
- REQUIRED – supports transaction if exisiting, creates new if not
- REQUIRES_NEW – always create a new transaction, and suspend the current transaction if one exists
- MANDATORY – supports the current transaction, throws an exception if none exists
- NEVER – execute non-transactionally, throw an exception if a transaction exists
- NOT_SUPPORTED - execute non-transactionally, suspend the current transaction if one exists
- NESTED – executes within a nested transaction if current transaction exists, else does like PROPAGATION_REQUIRED

Transactions Propagation





Source: https://docs.spring.io/spring-framework/docs/

TransactionStatus

```
public interface TransactionStatus extends SavepointManager {

    boolean isNewTransaction();

    boolean hasSavepoint();

    void setRollbackOnly();

    boolean isRollbackOnly();

    void flush();

    boolean isCompleted();

}
```


Source: https://docs.spring.io/spring-framework/docs/

Transactions and Concurrency

- **DataSourceTransactionManager** – JDBC local transactions, allows thread bound connections, obtained

```
<bean id="txManager"
class="org.springframework.jdbc.datasource.DataSourceTransactionManager
">
    <property name="dataSource" ref="dataSource"/>
</bean>
```

- **JtaTransactionManager** – using global JTA tranactions

```
<jee:jndi-lookup id="dataSource" jndi-name="jdbc/articles"/>
<bean id="txManager"
    class="org.springframework.transaction.jta.JtaTransactionManager"/>
```

- **@Transactional** – declarative transactions
- **TransactionTemplate** or directly using **PlatformTransactionManager** – programmatic transactions

Declarative Transaction Demarcation

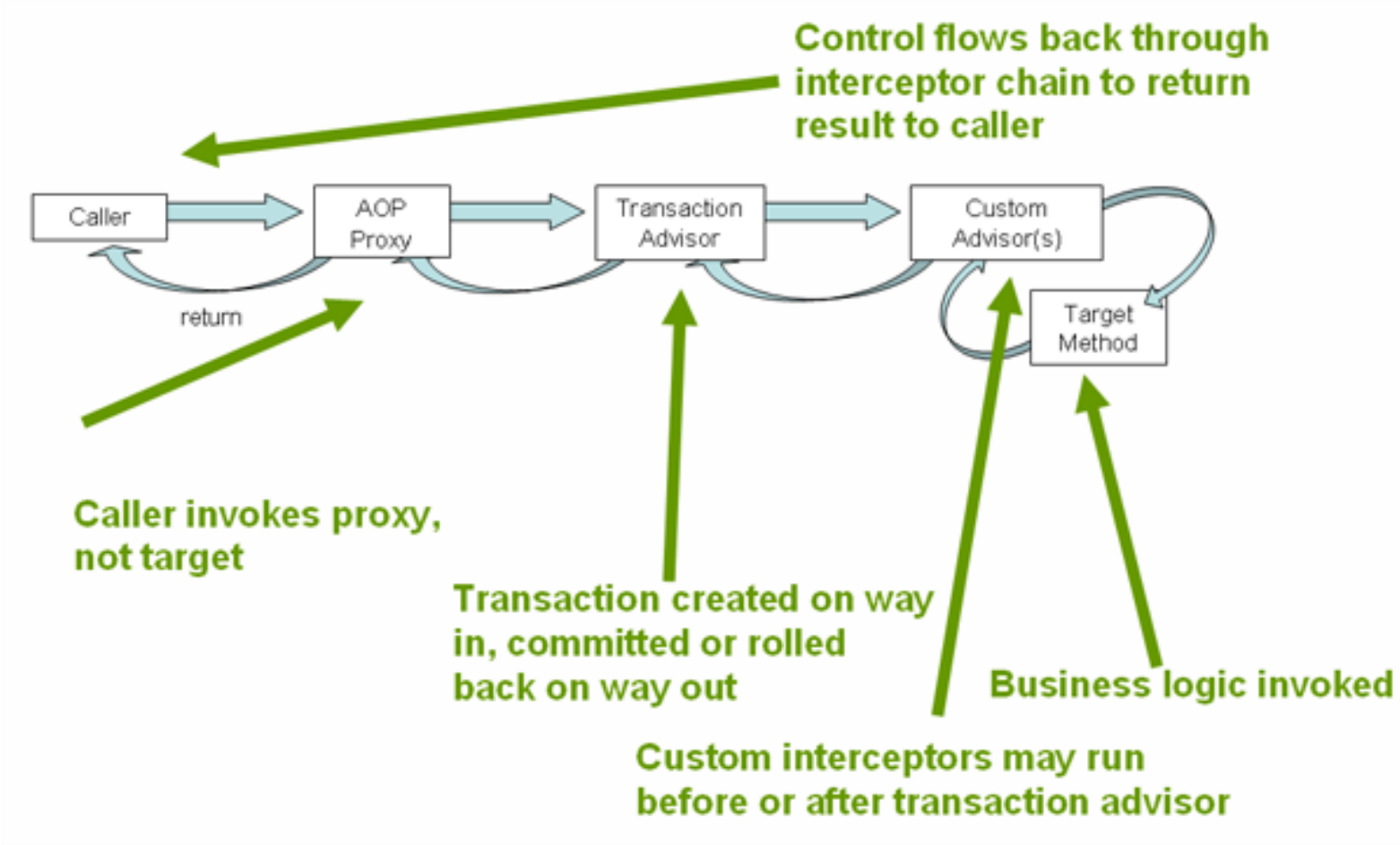
- Enabling declarative transactions:
  - **@EnableTransactionManagement**
  - **<tx:annotation-driven/>**

- **@Transactional** attributes: value (optional qualifier specifying the transaction manager to be used), propagation, isolation, readOnly, timeout (in seconds), rollbackFor (optional array of exception classes that must cause rollback), rollbackForClassName, noRollbackFor (optional array of exception classes that must not cause rollback), noRollbackForClassName

```
@Transactional(propagation = Propagation.REQUIRED)
public List<Article> createArticlesBatch(List<Article>
articles){
     List<Article> created = articles.stream()
            .map(article -> addArticle(article))
            .collect(Collectors.toList());
     return created;
}
```


Source: https://docs.spring.io/spring-framework/docs/

Transactions via AOP Proxies



Source: https://docs.spring.io/spring-framework/docs/

Customizing Transactions using AOP

```
<aop:config>
   <aop:pointcut id="entryPointMethod"
                 expression="execution(* x.y..*Service.*(..))"/>

   <aop:advisor advice-ref="txAdvice" pointcut-ref="entryPointMethod"
order="2"/>

   <aop:aspect id="profilingAspect" ref="profiler">
       <aop:pointcut id="methodWithReturn"
                     expression="execution(!void x.y..*Service.*(..))"/>
       <aop:around method="profile" pointcut-ref="methodWithReturn"/>
   </aop:aspect>
</aop:config>

<tx:advice id="txAdvice" transaction-manager="txManager">
   <tx:attributes>
       <tx:method name="get*" read-only="true"/>
       <tx:method name="*"/>
   </tx:attributes>
</tx:advice>
```


Source: https://docs.spring.io/spring-framework/docs/

Programmatic Transactions - I

```
public List<Article> createArticlesBatch(List<Article> articles)
{
    return transactionTemplate.execute(
        new TransactionCallback<List<Article>>() {
            public List<Article> doInTransaction(
                                                TransactionStatus status)
{
                List<Article> created = articles.stream()
                    .map(article -> {
                        try {
                            return addArticle(article);
                        } catch (ConstraintViolationException ex) {
                            log.error("Error:{}",ex.getMessage());
                            status.setRollbackOnly();
                            return null;
                        }
                }).collect(Collectors.toList());
                return created;
            }
    });
}
```


Source: https://docs.spring.io/spring-framework/docs/

Programmatic Transactions - II

```
public List<Article> createArticlesBatch(List<Article> articles) {
    DefaultTransactionDefinition def = new DefaultTransactionDefinition();
    def.setPropagationBehavior(TransactionDefinition.PROPAGATION_REQUIRED);
    def.setTimeout(5);
    TransactionStatus status = transactionManager.getTransaction(def);
    List<Article> created = articles.stream()
        .map(article -> {
            try {
                Article resultArticle = addArticle(article);
                applicationEventPublisher.publishEvent(
                                new ArticleCreationEvent(resultArticle));
                return resultArticle;
            } catch (ConstraintViolationException ex) {
                log.error("Error: {}", ex.getMessage());
                transactionManager.rollback(status); // ROLLBACK
                throw ex;
            }
        }).collect(Collectors.toList());
    transactionManager.commit(status); // COMMIT
    return created;
}
```


Source: https://docs.spring.io/spring-framework/docs/

@TransactionalEventListener

```
@TransactionalEventListener
public void
handleArticleCreatedTransactionCommit(ArticleCreationEvent
creationEvent) {
    log.info(">>> Transaction COMMIT for article: {}",
            creationEvent.getArticle());
}


@TransactionalEventListener(phase = TransactionPhase.AFTER_ROLLBACK)
public void
handleArticleCreatedTransactionRollaback(ArticleCreationEvent
creationEvent) {
    log.info(">>> Transaction ROLLBACK for article: {}",
            creationEvent.getArticle());
}
```


Source: https://docs.spring.io/spring-framework/docs/

Java Persistence API (JPA)

- **JPA four main parts:**
  - Java Persistence API
  - JPA Query Language
  - Java Persistence Criteria API
  - Object to Relational Mapping (ORM) metadata
  - JPA Entity Graph API
- **JPA Entity Classes**
  - persistent fields
  - persistent properties
- **@Entity** annotation

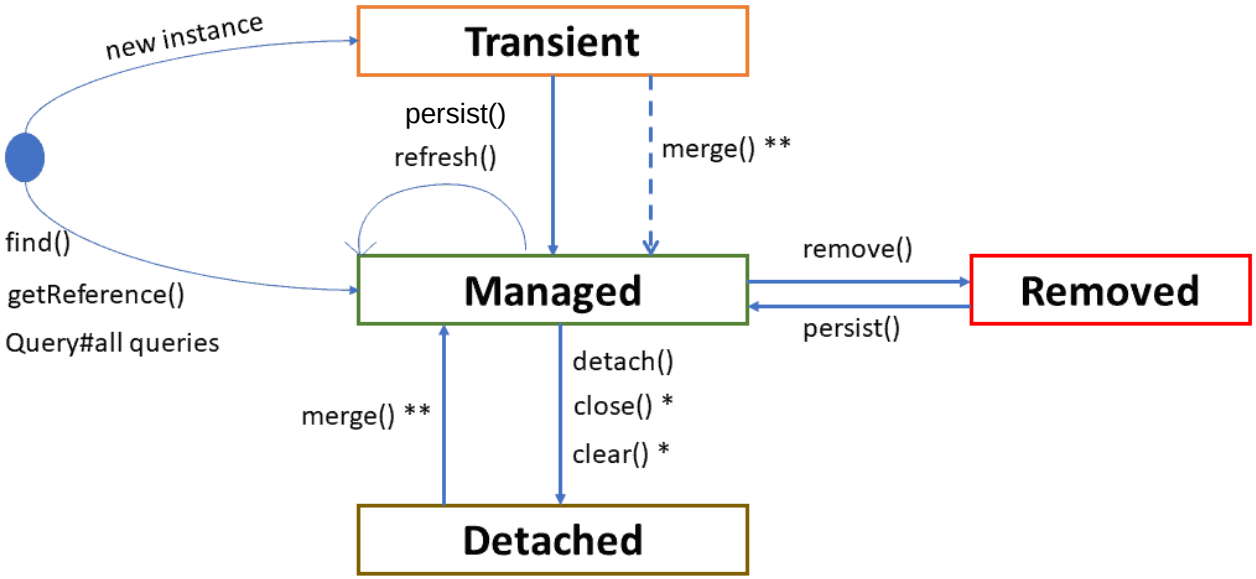
Object-Relational Mapping (ORM)

- Package: javax.persistence
- Simple keys - @Id annotation
- Composite keys
  - Primary Key Class – requirements and structure
  - Annotations – @EmbeddedId, @IdClass
- Realtions between entity objects –
  - uni- and bi-directional,
  - 1:1, 1:many, many:1 many:many

Advantages of Spring ORM

- Easier testing
- Common data access exceptions
- General resource management
- Integrated transaction management

JPA Entity Lifecycle



** → Merge returns a managed instance, original remains in same state

ORM Cascade Updates

- Entities that have a dependency relationship can be managed declaratively by JPA using CascadeType:
  - **ALL** – всички операции са каскадни
  - **DETACH** – каскадно отстраняване
  - **MERGE** – каскадно сливане
  - **PERSIST** – каскадно персистиране
  - **REFRESH** – каскадно обновяване
  - **REMOVE** – каскадно премахване

```
@OneToMany(cascade=REMOVE,
mappedBy="customer")
public Set<Order> getOrders() { return orders; }
```

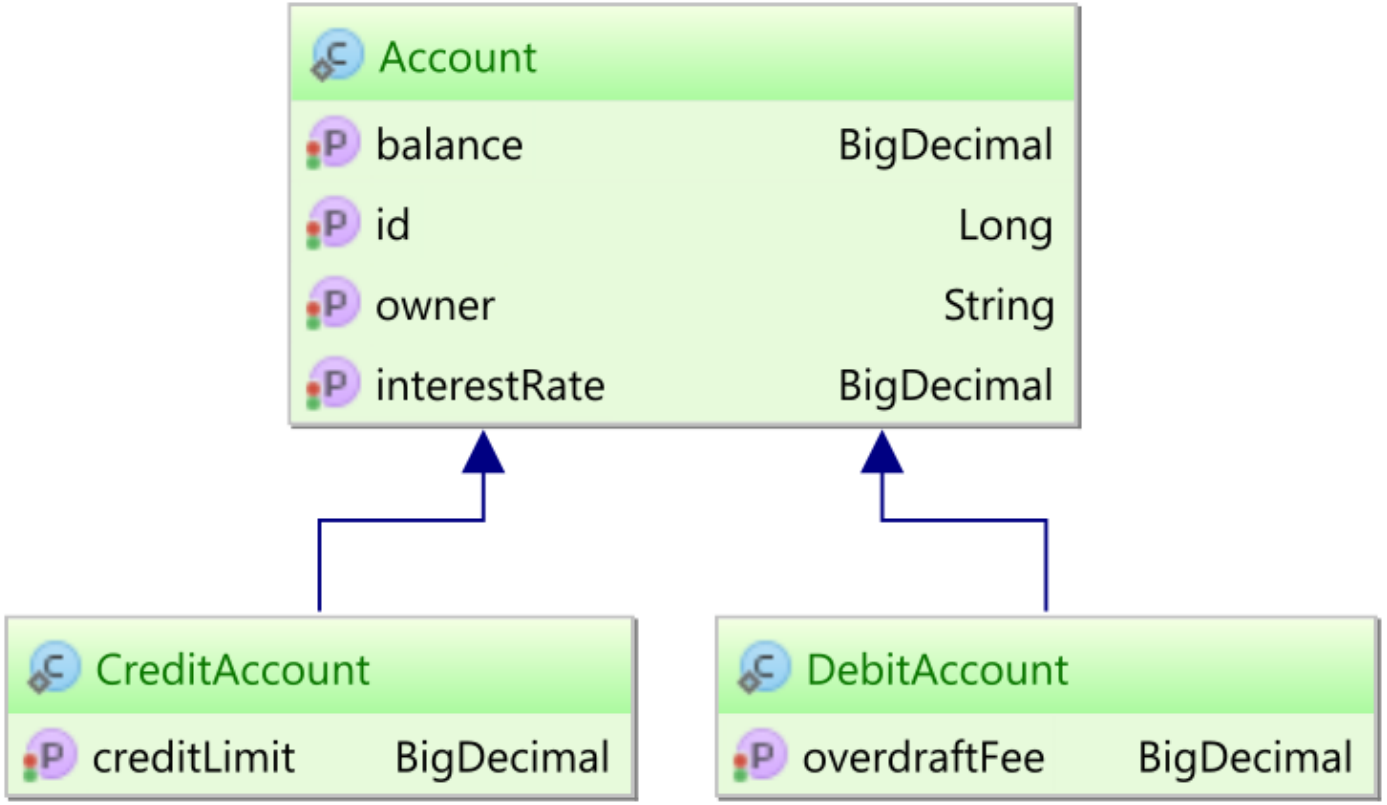
Entity Embeddables

- **@Embeddable** – анотира клас, който не е Entity, но може да бъде част от Entity
- **@Embedded** – embeds Embeddable class into Entity class
- Embedding can be hierarchical on multiple levels
- Annotations: **@AttributeOverride, @AttributeOverrides, @AssociationOverride, @AssociationOverrides**

Entity Inheritance

- Entity / Abstract entity
- Mapped superclass
- Non-entity superclass
- Entity -> DB tables mapping strategies
  - SingleTable per Class Hierarchy
  - TheTable per Concrete Class
  - The Joined Subclass Strategy

Entity Inheritance



Persistent Units

- Persistent Unit description in persistence.xml file:
  - description
  - provider
  - jta-data-source
  - non-jta-data-source
  - mapping-file
  - jar-file
  - class
  - exclude-unlisted-classes
  - properties

Persistent Unit Example 1

```
<persistence xmlns="http://java.sun.com/xml/ns/persistence"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    version="1.0"
    xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
    http://java.sun.com/xml/ns/persistence/persistence_1_0.xsd">
    <persistence-unit name="CustomerDBPU" transaction-type="JTA">
        <jta-data-source>jdbc/sample</jta-data-source>
        <class>customerdb.Customer</class>
        <class>customerdb.DiscountCode</class>
        <properties/>
    </persistence-unit>
</persistence>
```

Persistent Unit Example 2 - I

```
<?xml version="1.0" encoding="UTF-8"?>
<persistence version="1.0"
    xmlns="http://java.sun.com/xml/ns/persistence"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
    http://java.sun.com/xml/ns/persistence/persistence_1_0.xsd">
   <persistence-unit name="invoicingPU"
            transaction-type="RESOURCE_LOCAL">
    <provider>oracle.toplink.essentials.PersistenceProvider</provider>
      <class>myinvoice.dbentities.ProductDB</class>
      <class>myinvoice.dbentities.PositionDB</class>
      <class>myinvoice.dbentities.InvoiceDB</class>
```

Persistent Unit Example 2 - II

```
        <class>myinvoice.dbentities.ContragentDB</class>
        <properties>
            <property name="toplink.jdbc.user" value="root"/>
            <property name="toplink.jdbc.password" value="root"/>
            <property name="toplink.jdbc.url"
                    value="jdbc:mysql://localhost:3306/invoicing"/>
            <property name="toplink.jdbc.driver"
                    value="com.mysql.jdbc.Driver"/>
        </properties>
    </persistence-unit>
</persistence>
```

Collection Type Persistent Fields

- Field or properties should be of Collection or Map type (usually generic):
  - java.util.Collection
  - java.util.Set
  - java.util.List
  - java.util.Map
- @ElementCollection
- @CollectionTable – name of additional table
- @Embeddable, @Column
- @AttributeOverride, @AttributeOverrides

Main JPA Annotations

- @PersistenceUnit,
- @PersistenceContext
- @Entity
- @Id
- @OneToOne
- @OneToMany
- @ManyToMany
- @DiscrimainatorColumn
- @Column
- @JoinTable
- @JoinColumn
- @Embeddable
- @Embedded

JPA Entity Annotations Example

```java
@Entity
public class Article {
    @Id
    @GeneratedValue
    private Long id;

    @Length(min=3, max=80)
    private String title;

    @Length(min=3, max=2048)
    private String content;

    @NotNull
    @ManyToOne
    @JoinColumn(name="AUTHOR_ID", nullable=false)
    private User author;

    @Length(min=3, max=256)
    private String pictureUrl;

    @Temporal(TemporalType.TIMESTAMP)
    private Date created = new Date();


    @Temporal(TemporalType.TIMESTAMP)
    private Date updated = new Date();
… }
```

```java
@Entity
public class User implements UserDetails {
    @Id
    @GeneratedValue
    private long id;

    @NotNull
    @Length(min = 3, max = 30)
    private String username;
    ...

    @NonNull
    private String roles = "ROLE_USER";

    @OneToMany(mappedBy = "author",
               cascade = CascadeType.ALL,
               orphanRemoval=true)
    Collection<Article> articles =
        new ArrayList<>();

    @Temporal(TemporalType.TIMESTAMP)
    private Date created = new Date();

    @Temporal(TemporalType.TIMESTAMP)
    private Date updated = new Date();
… }
```

JPA Entities: @ManyToMany

```java
@Entity
public class Book {
    @Id @GeneratedValue
    private int id;

    @NotNull
    private String title;

    @ManyToOne
    @JoinColumn(name = "PUBLISHER_ID",
                referencedColumnName = "id")
    private Publisher publisher;

    @Column(name = "PUBLISHED_DATE") @PastOrPresent
    @DateTimeFormat(iso = DateTimeFormat.ISO.DATE)
    private LocalDate publishedDate;

    @Pattern(regexp = "\\d{10}|\\d{13}")
    private String isbn;

    @NotNull @Min(0)
    private double price;

    @ManyToMany(fetch = FetchType.EAGER)
    @JoinTable(name="BOOK_AUTHOR", joinColumns=
      @JoinColumn(name="BOOK_ID",referencedColumnName="ID"),
                inverseJoinColumns=
      @JoinColumn(name="AUTHOR_ID",referencedColumnName="ID")
    )
    private List<Author> authors = new ArrayList<>();
… }
```

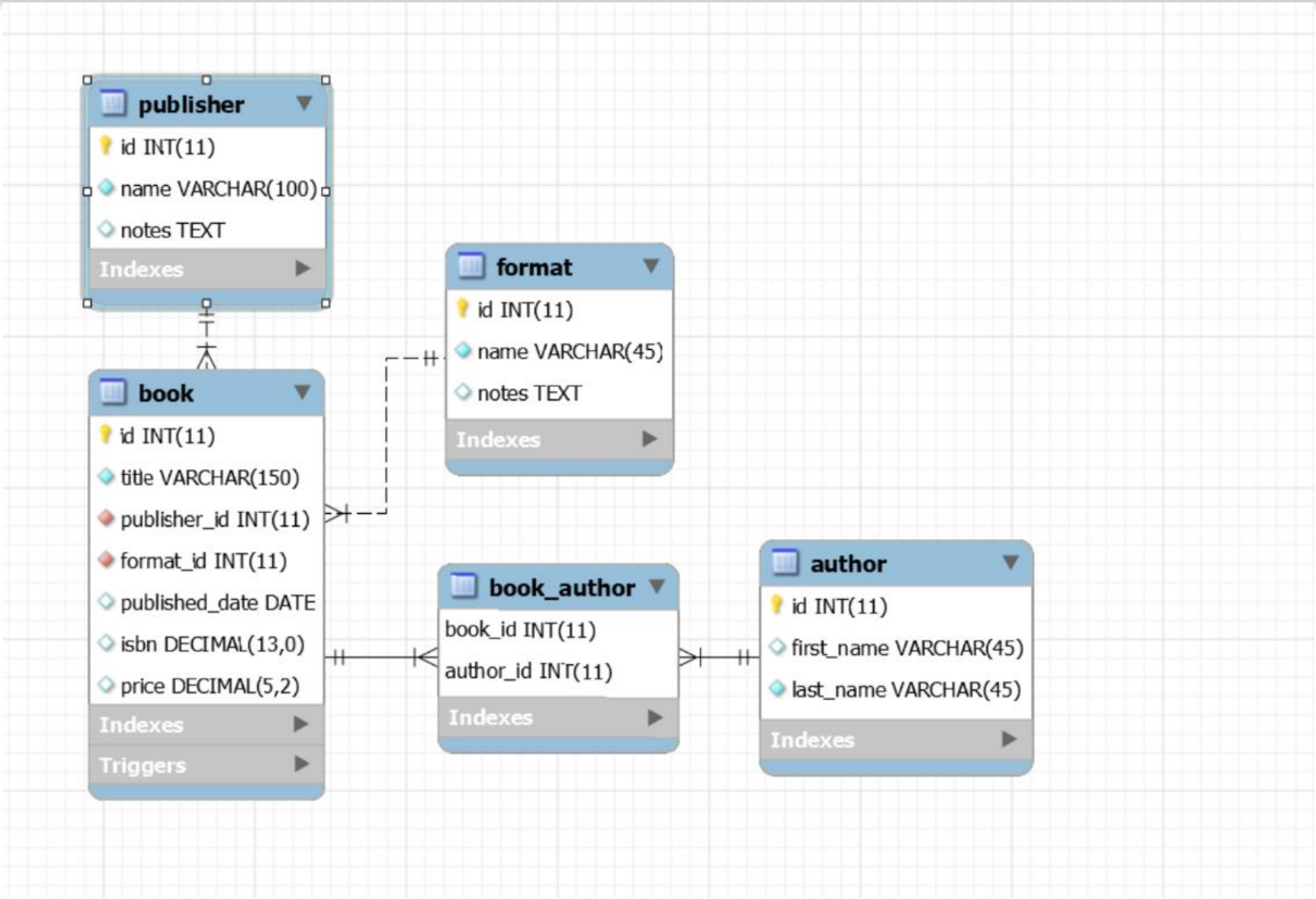
```java
@Entity
public class Author {
        @Id @GeneratedValue
        private int id;

        @NotNull
        @Length(min=2, max=60)
        @Column(name = "first_name")
        private String firstName;

        @NotNull
        @Length(min=2, max=60)
        @Column(name = "last_name")
        private String lastName;

        @ManyToMany(mappedBy = "authors",
                    fetch = FetchType.EAGER)
        List<Book> books = new ArrayList<>();
… }
```

JPA Entities: ER Diagram



JPA Query Language Syntax

Select Statements - SELECT, FROM, WHERE, GROUP BY, HAVING, and ORDER BY.

The SELECT clause defines the types of the objects or values returned by the query.

The FROM clause defines the scope of the query by declaring one or more identification variables, which can be referenced in the SELECT and WHERE clauses. An identification variable represents one of the following elements:

- The abstract schema name of an entity
- An element of a collection relationship
- An element of a single-valued relationship
- A member of a collection that is the multiple side of a one-to-many relationship

The WHERE clause is a conditional expression that restricts the objects or values retrieved by the query. Although the clause is optional, most queries have a WHERE clause.

The GROUP BY clause groups query results according to a set of properties.

The HAVING clause is used with the GROUP BY clause to further restrict the query results according to a conditional expression.

The ORDER BY clause sorts the objects or values returned by the query into a specified order.

JPA Query Language Syntax

Update and delete statements provide bulk operations over sets of entities. These statements have the following syntax:

update_statement :: = update_clause [where_clause]

delete_statement :: = delete_clause [where_clause]

The update and delete clauses determine the type of the entities to be updated or deleted. The WHERE clause may be used to restrict the scope of the update or delete operation.

Java Persistence Query Language

- Object-oriented database queries
- Navigation
- Abstract schema
- Path expression
- State field
- Relationship field

Java Persistence Query Language

- SELECT
- FROM
- WHERE
- GROUP BY
- HAVING
- ORDER BY
- UPDATE
- DELETE
- AS, IN
- LIKE
- EXISTS, ANY, ALL
- NEW

Basic JPA Query usage

```
Query query = entityManager.createQuery(
                "select p " +
                    "from Person p " +
                    "where p.name like :name")
            // timeout - in milliseconds
            .setHint("javax.persistence.query.timeout", 2000)
            // flush only at commit time
            .setFlushMode(FlushModeType.COMMIT);
```

Hibernate Flush Modes

ALWAYS

Flushes the Session before every query.

AUTO

This is the default mode, and it flushes the Session only if necessary.

COMMIT

The Session tries to delay the flush until the current Transaction is committed, although it might flush prematurely too.

MANUAL

The Session flushing is delegated to the application, which must call Session.flush() explicitly in order to apply the persistence context changes.

JPA defines some standard hints - I

javax.persistence.query.timeout - Defines the query timeout, in milliseconds.

javax.persistence.fetchgraph - Defines a fetchgraph EntityGraph. Attributes explicitly specified as AttributeNodes are treated as FetchType.EAGER (via join fetch or subsequent select). For details, see the EntityGraph discussions in Fetching.

javax.persistence.loadgraph - Defines a loadgraph EntityGraph. Attributes explicitly specified as AttributeNodes are treated as FetchType.EAGER (via join fetch or subsequent select). Attributes that are not specified are treated as FetchType.LAZY or FetchType.EAGER depending on the attribute's definition in metadata. For details, see the EntityGraph discussions in Fetching.

org.hibernate.cacheMode - Defines the CacheMode to use. See org.hibernate.query.Query#setCacheMode.

org.hibernate.cacheable - Defines whether the query is cacheable. true/false. See org.hibernate.query.Query#setCacheable.

JPA defines some standard hints - II

org.hibernate.cacheRegion - For queries that are cacheable, defines a specific cache region to use. See org.hibernate.query.Query#setCacheRegion.

org.hibernate.comment - Defines the comment to apply to the generated SQL. See org.hibernate.query.Query#setComment.

org.hibernate.fetchSize - Defines the JDBC fetch-size to use. See org.hibernate.query.Query#setFetchSize.

org.hibernate.flushMode - Defines the Hibernate-specific FlushMode to use. See org.hibernate.query.Query#setFlushMode. If possible, prefer using javax.persistence.Query#setFlushMode instead.

org.hibernate.readOnly - Defines that entities and collections loaded by this query should be marked as read-only. See org.hibernate.query.Query#setReadOnly.

JPA retrieving result set

In terms of execution, JPA Query offers 3 different methods for retrieving a result set:

Query#getResultList() - executes the select query and returns back the list of results.

Query#getResultStream() - executes the select query and returns back a Stream over the results.

Query#getSingleResult() - executes the select query and returns a single result. If there were more than one result an exception is thrown.

JPA Setup in Spring

```
<beans>
    <bean id="myEmf"
class="org.springframework.orm.jpa.LocalEntityManagerFactoryBean">
        <property name="persistenceUnitName" value="myPersistenceUnit"/>
    </bean>
</beans>
```

```
<beans>
    <jee:jndi-lookup id="myEmf" jndi-name="persistence/myPersistenceUnit"/>
</beans>
```

```
<beans>
    <bean id="myEmf"
        class="org.springframework.orm.jpa.LocalContainerEntityManagerFactoryBean">
        <property name="dataSource" ref="someDataSource"/>
        <property name="loadTimeWeaver">
            <bean
class="org.springframework.instrument.classloading.InstrumentationLoadTimeWeaver"/>
        </property>
    </bean>
</beans>
```

JSR-303: Bean Validation (1)

- Bean Validation стартира през юли 2006 - JSR 303
- Финализирана е на 16 ноември 2009
- Валидацията е обща задача, която се осъществява през всички слоеве на приложението – от презентационния до персистирането на данните
- Често една и съща логика за валидация се реализира многократно във всеки слой, което води до чести грешки е несъответствия, както и до дублиране на усилия
- За да се справят с проблема, често разработчиците кодират валидационната логика директно в домейн модела, което води до смесване на бизнес логика и метаданни за валидиране на отделните свойства

JSR-303: Bean Validation (2)

- JSR 303: Bean Validation предлага набор от стандартни ограничения (constraints) относно данните, под формата на анотации, които обозначават полета, методи или класове на JavaBean компоненти, като например JPA Entities или JSF Managed Beans
- Има множество предварително дефинирани анотации, както и възможност за създаване на собствени такива и свързването им с клас, който да реализира валидационната логика
- Вградените анотации са дефинирани в пакет javax.validation.constraints

Bean Validation Annotations (1):

- @AssertFalse – елемент от булев тип трябва да е лъжа
- @AssertTrue – елемент от булев тип трябва да е истина
- @Min, @DecimalMin – минимална стойност на елемент от числов тип
- @Max, @DecimalMax – максимална стойност на елемент от числов тип
- @Digits – атрибути fraction и integer за дробната и цялата част на елемент от числов тип
- @Future – валидиране на бъдеща дата (Date и Calendar)
- @Past – валидиране на минала дата (Date и Calendar)
- @Size – min и max размер на String, Collection, Map или Array

Bean Validation Annotations (2):

- @NotNull – елементът трябва да е различен от null
- @Null – елементът трябва е null
- @Pattern – елементът трябва да съответствува на посочения в атрибута regexp регулярен израз
- @Valid – анотация в пакета javax.validation, която указва, че трябва да се извърши рекурсивна валидация на всички обекти свързани с посочения обект
- Възможно е създаване на нови собствени анотации и композитни анотации с използване на @Constraint, @GroupSequence, @ReportAsSingleViolation, @OverridesAttribute

Bean Validation Examples:

```
public class Email {
    @NotEmpty @Pattern(".+@.+\\.[a-z]+")
    private String from;
    @NotEmpty @Pattern(".+@.+\\.[a-z]+")
    private String to;
    @NotEmpty
    private String subject;
    @Min(1) @Max(10)
    private Integer priority;
    @NotEmpty
    private String body;
    ...
}
```

Bean Validation – Custom Annotation:

```
@Size(min=4, max=4)
@ConstraintValidator(validatedBy = PostCodeValidator.class)
@Documented
@Target({ANNOTATION_TYPE, METHOD, FIELD})
@Retention(RUNTIME)
public @interface PostCode {
    public abstract String message() default
            "{package.name.PostCode.message}";
    public abstract Class<?>[] groups() default {};
    public abstract Class<? extends ConstraintPayload>[]
                        payload() default {};
}
```

Bean Validation – Class PostCodeValidator

```
public class PostCodeValidator implements
                                ConstraintValidator<PostCode, String> {
   private final static Pattern POSTCODE_PATTERN =
                                Pattern.compile("\\d{4}");
   public void initialize(PostCode constraintAnnotation) { }
   public boolean isValid(String value,
                                 ConstraintValidatorContext context) {
      return POSTCODE_PATTERN.matcher(value).matches();
   }
}
```

Bean Validation – композитна анотация:

```
@ConstraintValidator(validatedBy = {})   @Documented
@Target({ANNOTATION_TYPE, METHOD, FIELD})
@Retention(RUNTIME)
@Pattern(regexp = "\\d{4}")
@ReportAsSingleViolation
public @interface PostCode {
    public abstract String message() default
            "{package.name.PostCode.message}";
  public abstract Class<?>[] groups() default {};
  public abstract Class<? extends ConstraintPayload>[]
                        payload() default {};
}
```

Additinal Examples

Learning Spring 5 book examples are available @ GitHub:https://github.com/PacktPublishing/Learning-Spring-5.0

Spring 5 Core Referenc Documentation: https://docs.spring.io/spring/docs/current/spring-framework-reference/data-access.html

JPA in Java EE 6 Tutorial – https://docs.oracle.com/javaee/6/tutorial/doc/bnbpy.html

Thank's for Your Attention!

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