CMPS 356

Web API Using Java EE

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QU

Outline

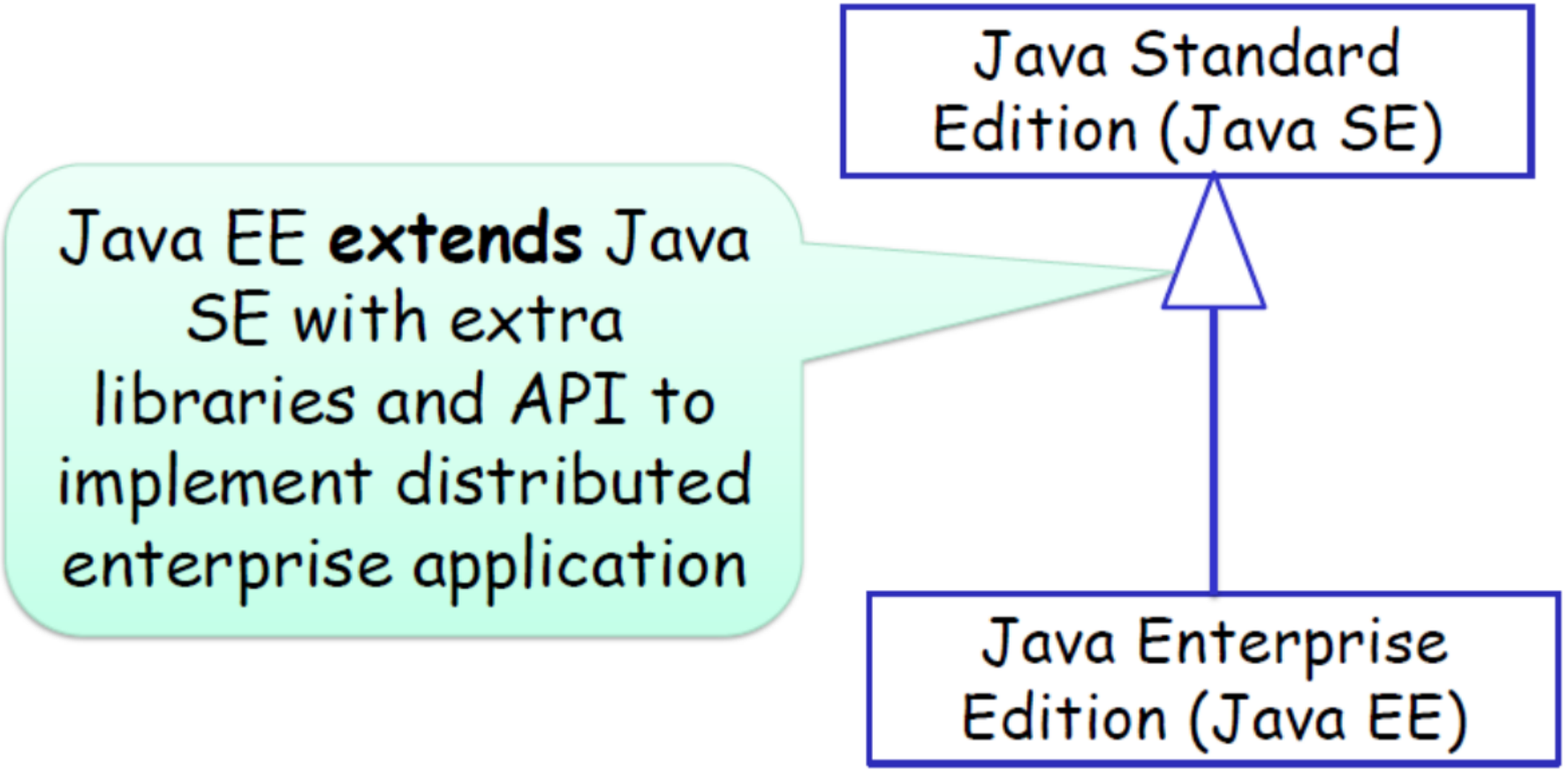
1. Introduction to Java EE
2. Services Programming using JAX-RS
3. Review of JDBC
4. Java Persistence API (JPA)
5. JPA Programming

Introduction to Java EE

What is Java EE?

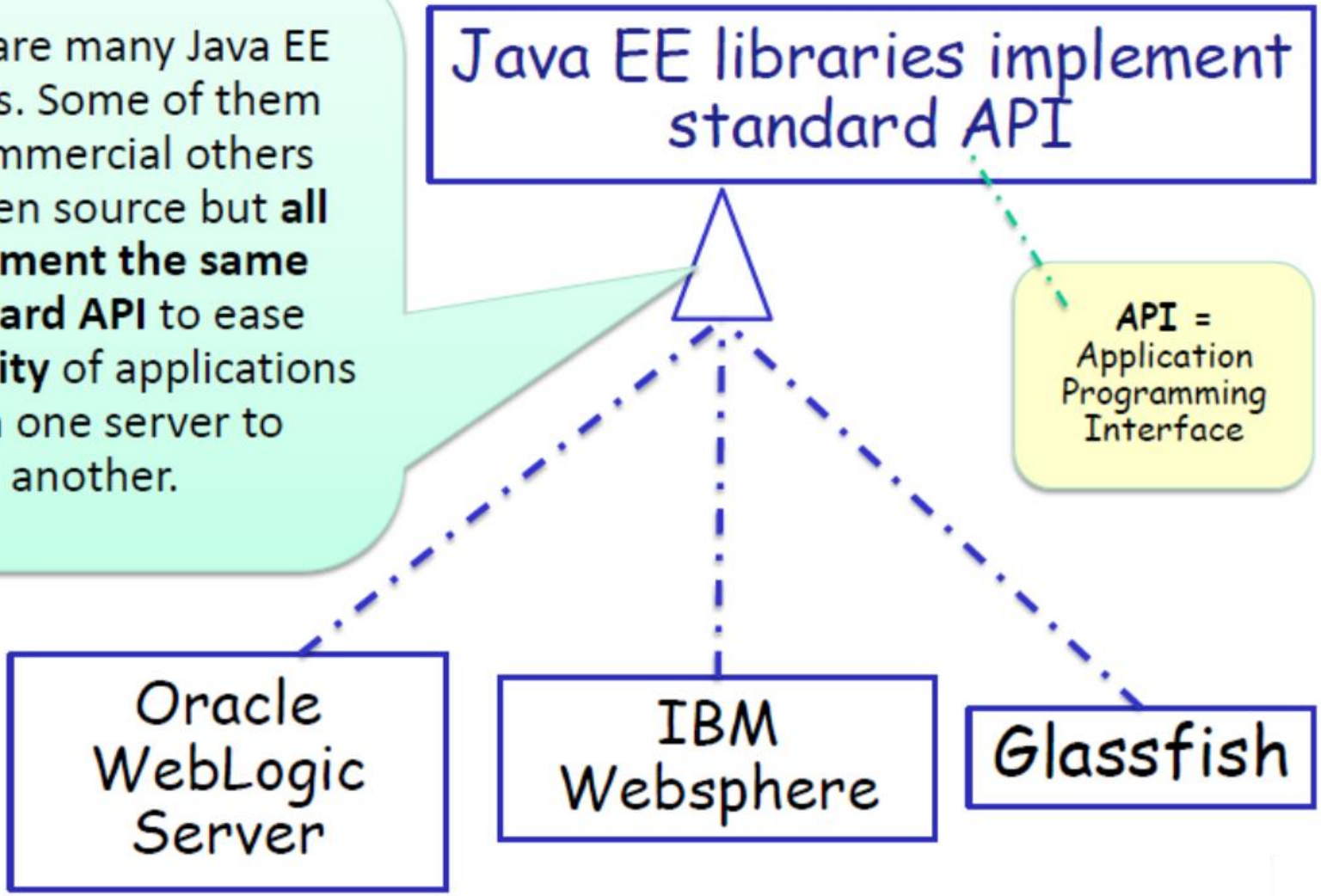
- Java EE is a widely used platform for building enterprise, web-deployed applications
- It is a set of standard Java APIs for enterprise applications
  - API Standardization via Java Community Process (JCP)
- The Java EE platform differs from Java SE in that it adds libraries which provide functionality to build and deploy distributed, multi-tier Java applications, based largely on modular components running on an application server
  - **Component/Container** design pattern

Java Editions



Java EE Servers

There are many Java EE servers. Some of them are commercial others are open source but **all implement the same standard API** to ease **portability** of applications from one server to another.



Java EE Servers

- IBM WebSphere Application Server
- OracleWebLogic Application Server
- Sun GlassFish
- JBoss Application Server
- Apache Geronimo
- SAP NetWeaver Application Server
- So many others both open source and commercial
- In this course will use a simple **Jetty** Web Server http://www.eclipse.org/jetty/

Services Programming using JAX-RS

JAX-RS

- JAX-RS is Java API for creating REST services
- JAX-RS uses annotations to simplify the development of REST services and clients
- Many implementations are available:
  - **Jersey**: reference implementation from Oracle
  - RESTEasy from JBoss
  - Apache CXF

@Path

- Specifies the URI Path of the resource corresponding to a class

```
@Path("/contacts")
@Stateless
public class ContactService {
```

- Variables can be embedded in the URI, and then retrieved with the **@PathParam** annotation

```
@GET
@Path("/{id}")
@Produces({MediaType.APPLICATION_JSON, MediaType.APPLICATION_XML})
public Response getContact(@PathParam("id") int contactId) {
    Contact contact = contactRepository.getContact(contactId);
    if (contact != null) {
```

Sub-resources

- **@Path** may be used on classes and such classes are referred to as root resource classes
- **@Path** may also be used on methods of root resource classes

```
@Path("/contacts")
@Stateless
public class ContactService {
    @GET
    @Path("/countries")
    @Produces(MediaType.APPLICATION_JSON)
    public Response getCountries() {
        List<String> countries = contactRepository.getCountries();
        String json = (new Gson()).toJson(countries);
        System.out.println(json);
        return Response.ok(json).build();
    }
```

HTTP Methods

- **@GET**, **@PUT**, **@POST**, **@HEAD** annotations correspond to the HTTP methods
  - Represent the actions to be performed on

```
@POST
@Consumes({MediaType.APPLICATION_JSON, MediaType.APPLICATION_XML})
public Response addContact(Contact contact) throws URISyntaxException {
    contact = contactRepository.addContact(contact);
    String location = String.format("/contacts/%s", contact.getContactId());
    String msg = String.format("contact #%s created successfully", contact.getCo
    return Response.created(new URI(location)).entity(msg).build();
}

@PUT
@Consumes({MediaType.APPLICATION_JSON, MediaType.APPLICATION_XML})
public Response updateContact(Contact contact) {
    contactRepository.updateContact(contact);
    String msg = String.format("Contact #%s updated sucessfully", contact.getCo
    return Response.ok(msg).build();
}
```

@Produces

- Specifies the MIME media types of **representations** a resource can produce typically XML or JSON (directly interpretable by JavaScript and Ajax)
  - Multiple representations of the same resource are allowed

```
@GET
@Path("/{id}")
@Produces({MediaType.APPLICATION_JSON, MediaType.APPLICATION_XML})
public Response getContact(@PathParam("id") int contactId) {
    Contact contact = contactRepository.getContact(contactId);
    if (contact != null) {
        return Response.ok(contact).build();
    } else {
        String msg = String.format("Contact # %d not found", contactId);
        return Response.status(Response.Status.NOT_FOUND).entity(msg).build();
    }
}
```

@Consumes

- It is used to specify the MIME media types of representations a resource can consume

```
@POST
@Consumes({MediaType.APPLICATION_JSON, MediaType.APPLICATION_XML})
public Response addContact(Contact contact) throws URISyntaxException {
    contact = contactRepository.addContact(contact);
    String location = String.format("/contacts/%s", contact.getContactId());
    String msg = String.format("contact #%s created successfully", contact.getCo
    return Response.created(new URI(location)).entity(msg).build();
}
```

Building Responses

- **Response** class can be used to build the HTTP response to return to the caller
  - You may specify the response headers such as the **status code** and the **location** of a newly created resource

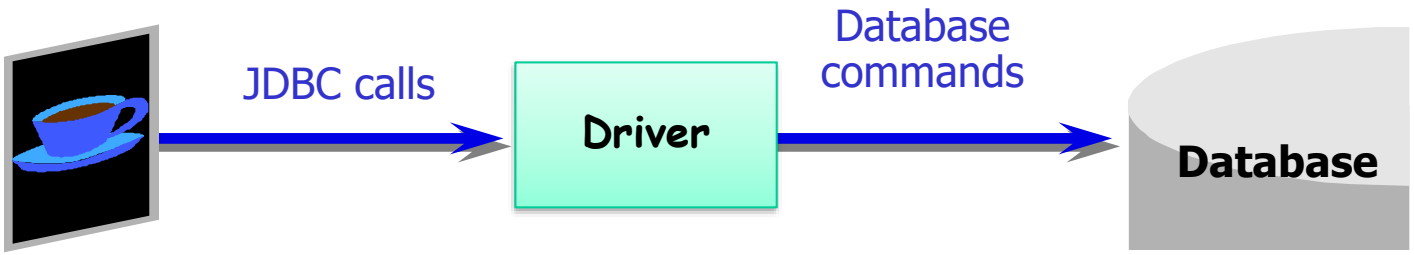
```
@POST
@Consumes({MediaType.APPLICATION_JSON, MediaType.APPLICATION_XML})
public Response addContact(Contact contact) throws URISyntaxException {
    contact = contactRepository.addContact(contact);
    String location = String.format("/contacts/%s", contact.getContactId());
    String msg = String.format("contact #%s created successfully", contact.getC
    return Response.created(new URI(location)).entity(msg).build();
}
```

Model the URIs

- In REST Services, endpoints are *resources* and identified with a URI
- For examples in an order management application we might have 3 top-level resources

```
/orders
/orders/{id}
/products
/products/{id}
/customers
/customers/{id}
```

JDBC Review

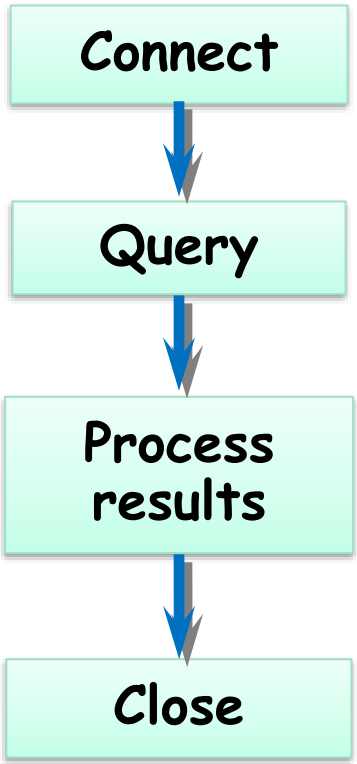


JDBC Overview

- JDBC (Java Database Connectivity) is an API for accessing databases from Java applications
  - API = a collection of classes and interfaces
  - JDBC allows establishing database **connection**, executing SQL **statements**, manipulating **query results**
- Need a JDBC driver for your database engine
- API represents key **runtime** entities: **Connection**, **Statement**, **ResultSet**
  - `Connection` is used to connect to the database
  - `Statement` used to submit a query to the database
  - `ResultSet` provides access to a table of data returned by executing a Statement

5 Steps for Using JDBC

1. Connect to the database
2. Create a Statement object
3. Execute a query using the Statement
4. Process the results
5. Close the connection



```
List<Surah> surahs = new ArrayList<>();
String connectionURL = "jdbc:derby:memory:cmsdb;create=true";
Class.forName("org.apache.derby.jdbc.EmbeddedDriver");

//try-with-resources statement declares the resources and ensures that each
resource is closed at the end of the statement.
try (Connection dbConnection = DriverManager.getConnection(connectionURL);
Statement statement = dbConnection.createStatement() ) {

String sqlText = "Select * from Surah";
ResultSet rs = statement.executeQuery(sqlText);

while (rs.next()) {
    int id = rs.getInt("id");
    String name = rs.getString("name");
    String englishName = rs.getString("englishName");
    int ayaCount = rs.getInt("ayaCount");
    String type = rs.getString("type");

    Surah surah = new Surah(id, name, englishName, ayaCount, type);
    surahs.add(surah);
}
```

SQL Statements

- Structured Query Language (SQL)
  - Language used to define, alter and access the elements described above
- **C**reating data:

```
INSERT into PERSON (first_name, last_name)
  VALUES ('Ahmed', 'Sayed')
```

- **R**eading data:

```
SELECT first_name FROM person WHERE last_name = 'Sayed'
```

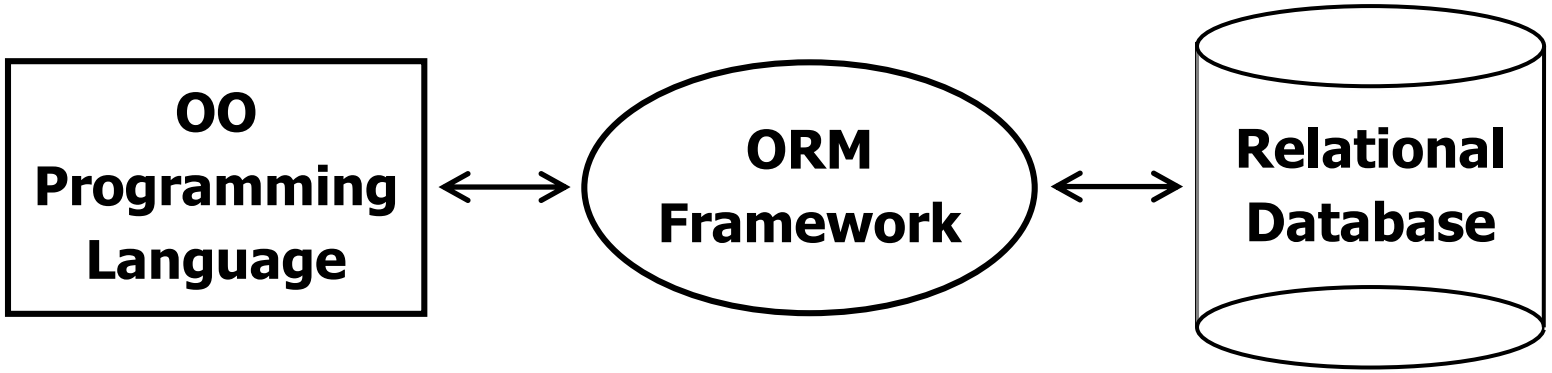
- **U**pdating data:

```
UPDATE person SET first_name = 'Ali' where
  last_name = 'Sayed'
```

- **D**eleting data:

```
DELETE from person where last_name = 'Sayed'
```

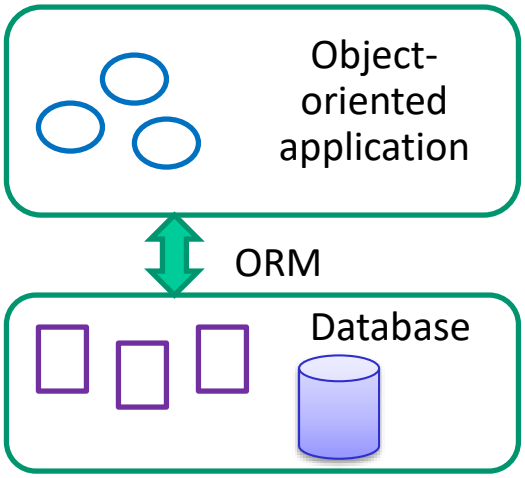
Java Persistence API (JPA)



ORM = Solution for Impedance Mismatch

- OO Programming style is widely used
- But… need easy way to persist object data in the database

Impedance Mismatch (conceptual mismatch between OOP and database worlds)



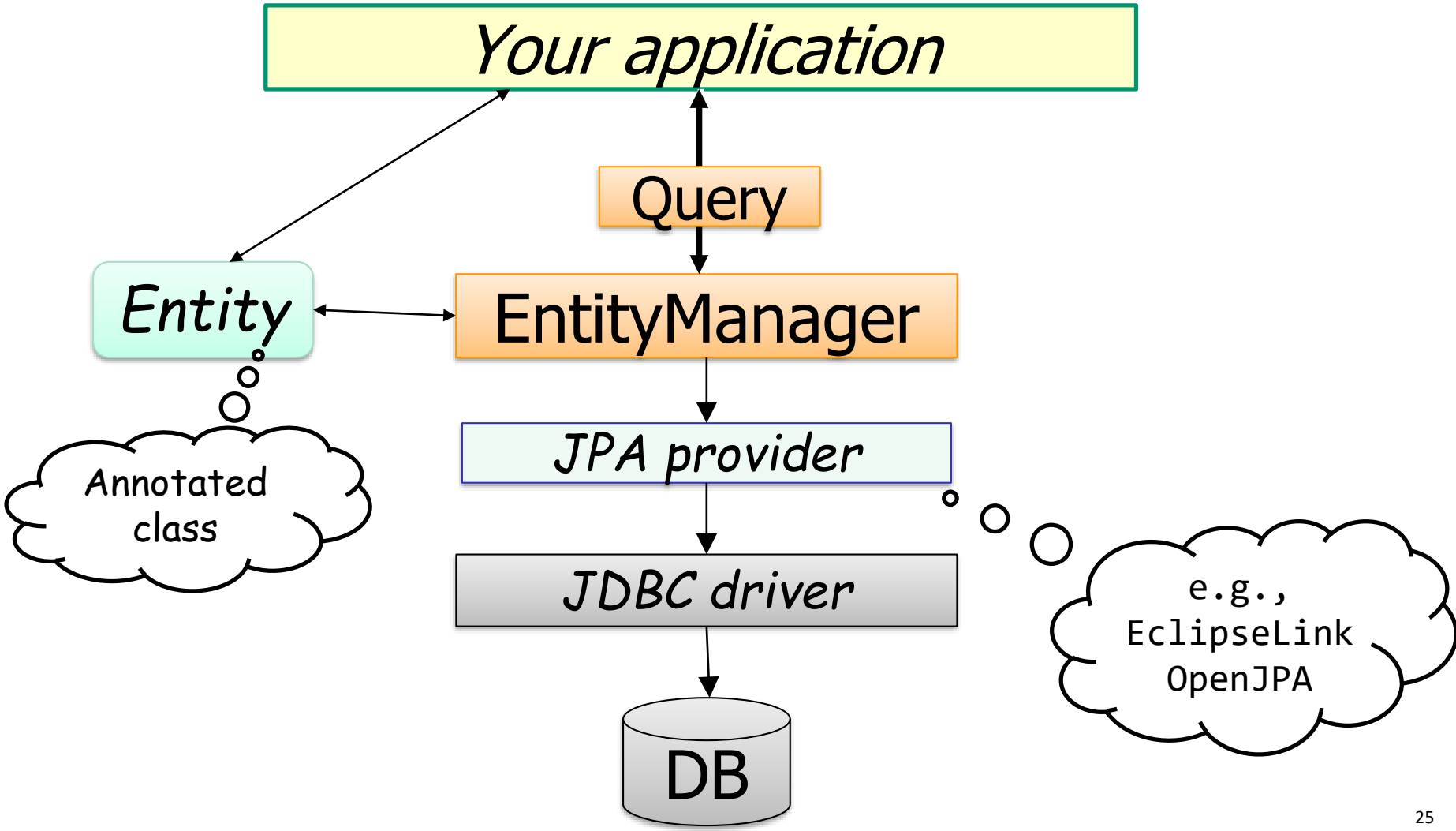
=> Solution is Object-Relational Mapping (ORM) – a software layer that **shuttles data back and forth between table rows and objects**

ORM Design Goals

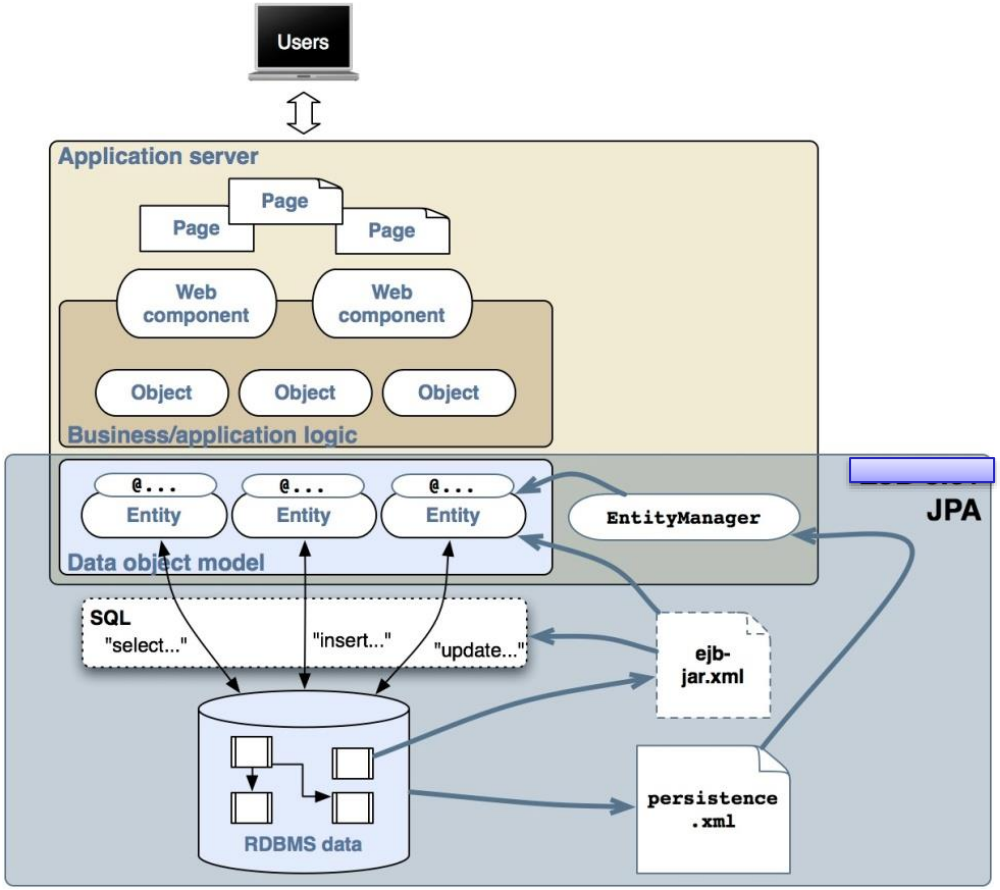
- Make it easier for OO developers to **save** and **retrieve** *objects* to/from DB
  - Query and retrieve data from tables and create the corresponding objects
  - **Synchronize** objects with the database by auto-generating the required insert/ update/delete SQL statements
  - Save and recreate ***associations*** between objects

Java Persistence API (JPA) Architecture

JPA is a Java standard for ORM



JPA Elements



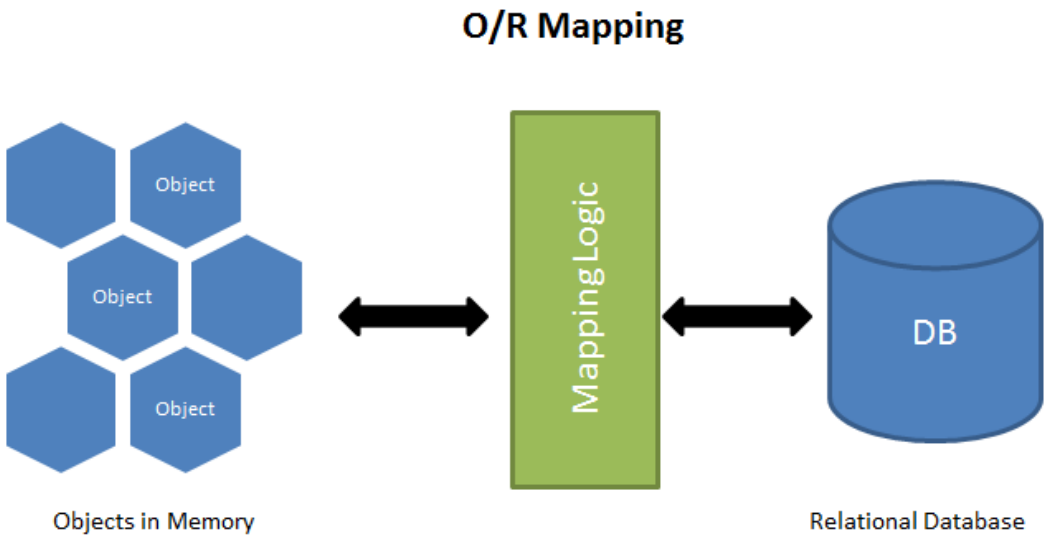
- **O-R mappings** using annotations defines how Java classes can be mapped to database tables
  - Entity X is mapped to table A, property X.Y is mapped to column A.B, etc.
- **Programming API** for storage/retrieval of entities (i.e., read/write to DB using `EntityManager`
  JPQL - Java Persistence Query Language
- **`Persistence.xml`**
  - Defines configuration details to connect to the database

persistence.xml

- A **`persistence.xml`** file defines one or more persistence units

```
<persistence version="2.0"
    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_2_0.xsd">
    <persistence-unit name="CmsDbPu">
        <!-- This allows auto-discovery of entity classes -->
        <exclude-unlisted-classes>false</exclude-unlisted-classes>
        <properties>
            <property name="javax.persistence.jdbc.driver" value="org.apache.derby.jdbc.EmbeddedDriver" />
            <property name="javax.persistence.jdbc.url" value="jdbc:derby:memory:cmsdb;create=true" />
            <!-- Possible values : "create", "drop", "drop-and-create", "none" -->
            <property name="javax.persistence.schema-generation.database.action" value="drop-and-create" />
            <property name="eclipselink.logging.level" value="FINE"/>
        </properties>
    </persistence-unit>
</persistence>
```

Basic JPA Annotations



Minimal Entity Annotation

- Entity represents a table in a relational database, and each entity instance corresponds to a row in that table

- A class must annotated with @Entity

```
@Entity
public class Employee {
        @Id int id;
        public int getId() { return id; }
        ….
}
```

Primary key

Each entity object has a unique id that Uniquely identifies the entity in memory and in the DB

Identifier Generation

- Identifiers can be generated in the database by specifying **`@GeneratedValue`** on the identifier
- The most common generation strategies is `IDENTITY`

  - The value gets auto incremented by 1 by the DB

```
@Id @GeneratedValue (strategy=GenerationType.IDENTITY)
int id;
```

Customizing Entity Annotation

- In most cases, the defaults are sufficient

-> Configuration by Exception

- By default the table name corresponds to the unqualified name of the class
  - Customization:

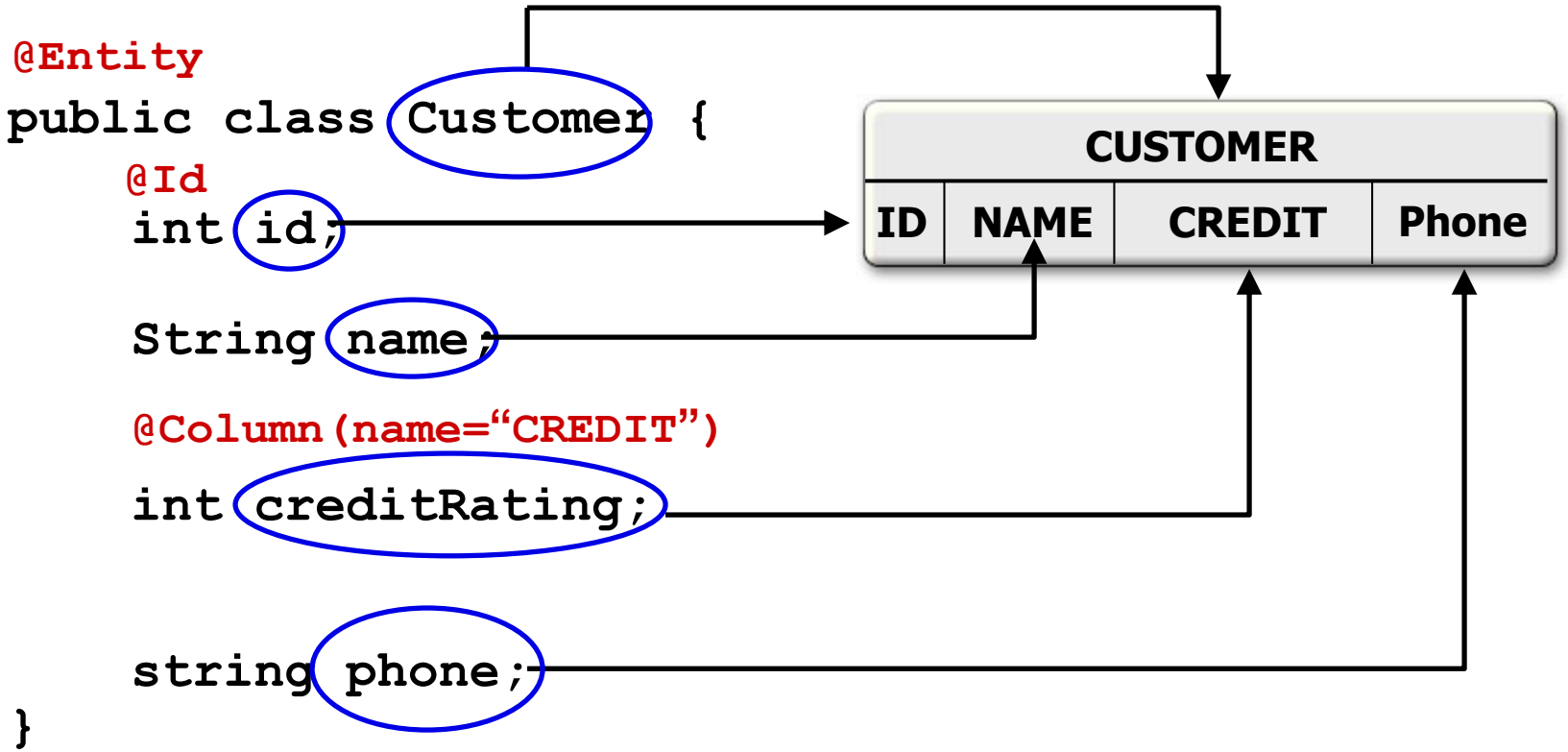
```
@Entity (name="FULLTIME_EMPLOYEE")
public class Employee{ …… }
```

- The defaults of columns can be customized using the `@Column` annotation

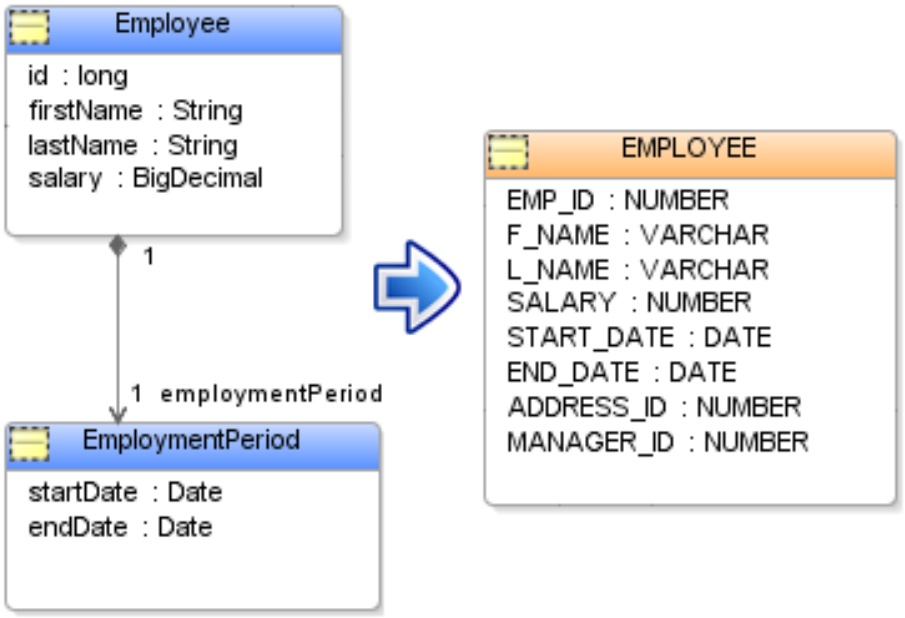
```
@Id @Column(name = “EMPLOYEE_ID”, nullable = false)
private String id;

@Column(name = “FULL_NAME” nullable = true, length = 100)
private String name;
```

Simple Mappings using Annotations



Mapping 1-to-1 Whole-Part to one Table



1-to-1 Whole-Part

Once Table

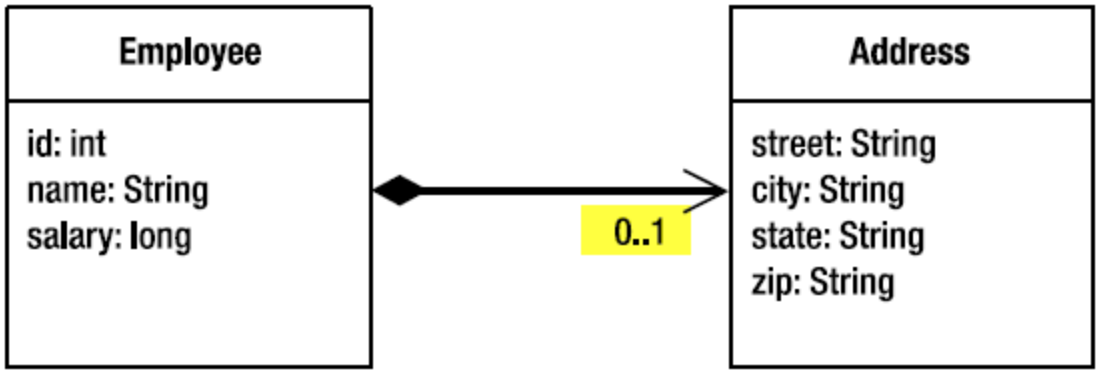
- Attributes of embeddable object is mapped to the same table that represents the owning entity
- An embeddable object is a dependent part and cannot be directly persisted or queried

```
@Embeddable
public class EmploymentPeriod {
  @Column(name="START_DATE")
  private java.sql.Date startDate;

  @Column(name="END_DATE")
  private java.sql.Date endDate;
  ...
}
```

```
@Entity
public class Employee {
  @Id
  private long id;
  ...
  @Embedded
  private EmploymentPeriod period;
  ...
}
```

@Embeddable Another Example

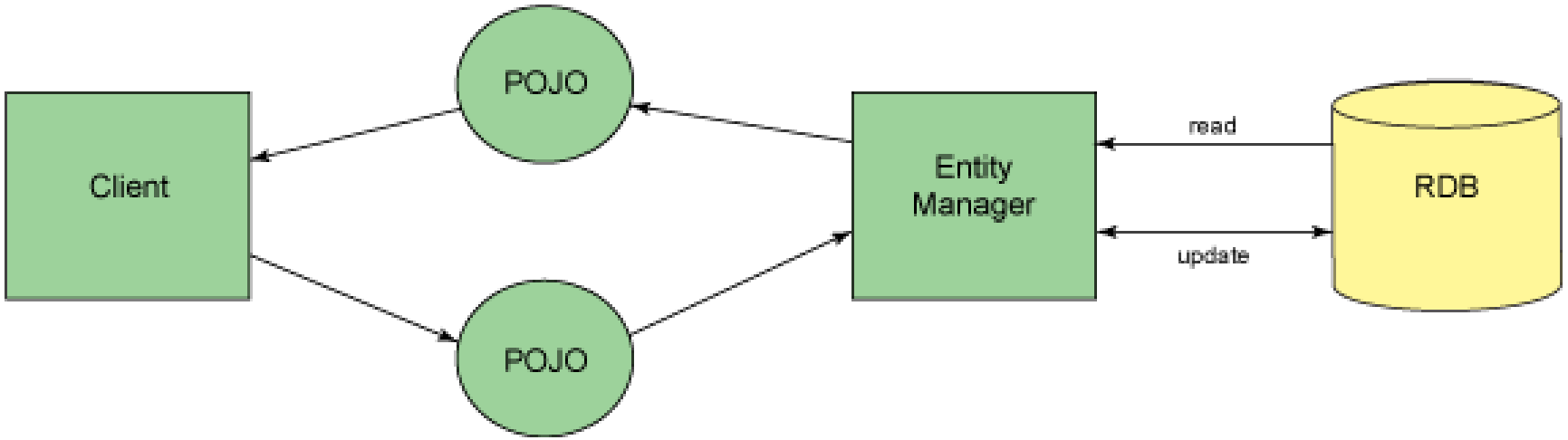


Employee *and* Address *relationship*

```
@Embeddable
public class Address {
    private String street;
    private String city;
    private String state;
    @Column(name="ZIP_CODE")
    private String zip;
    // ...
}
```

```
@Entity
public class Employee {
    @Id private int id;
    private String name;
    private long salary;
    @Embedded private Address address;
    // ...
}
```

JPA Programming



Entity Manager

- Entities are managed by the **`Entity Manager`**
- The Entity Manager is the most important class in JPA.
- It contains the lifecycle APIs for entities
  - `find()`, `persist()`, `merge()`, `remove()`
- Create Queries
  - `createNamedQuery`, `createQuery()`, `createNativeQuery()`

Entity Manager Operations

- EntityManager API
  - `persist()` - **Insert** the an entity instance into the PC
  - `remove()` - **Delete** the entity instance from the PC
  - `refresh()` - **Reload** the entity instance from the DB
  - `merge()` - **Update** an entity instance in the PC
  - `find()` - **Find** an entity instance by primary key
  - `contains()` - Determine if entity is managed by PC
  - `flush()` - **Synchronize** the PC with the database
  - `createQuery()` – `create` Java Persistence Query Language (JPQL) query (JPQL is very similar to SQL)
  - `createNativeQuery()` - Create a **SQL query**

find()

- Gets an entity instance by Primary Key. Returns null if not found

```
EntityManagerFactory entityManagerFactory =
      Persistence.createEntityManagerFactory("CmsDbPu");

EntityManager entityManagerFactory.createEntityManager();

public Customer getCustomer(long customerId) {
    return em.find(Customer.class, customerId);
}
```

persist()

- Insert a new entity instance

```
public Surah addSurah(Surah sura) {
    EntityManager em = entityManagerFactory.createEntityManager();
    EntityTransaction tx = em.getTransaction();
    try {
        tx.begin();
        em.persist(sura);
        tx.commit();
    } catch (Exception e) {
        tx.rollback();
        throw e;
    }
    return sura;
}
```

- It is common to return the new entity as it contains the auto-generated **id**

remove()

- Delete an entity instance

```
public void removeCustomer(int customerId) {
   …
   Customer customer = em.getReference(Customer.class, customerId);
   entityManager.remove(customer);
}                          OR
public void removeCustomer(int customerId) {
   …
   Query query = em.createQuery("delete from Customer
        where customerId = :customerId");
    query.setParameter("customerId", customerId);
    query.executeUpdate();
}
```

merge()

- Updates an entity instance

```
public void update(Customer customer) {
        …
      em.merge(customer);
}
```

JPA Queries

- JPA supports **named** queries, **dynamic** queries and **native** queries
- Query instances are created usng the EntityManager methods:

  `createNamedQuery`(), **`createQuery`**() & **createNativeQuery**

- Query class API:

`getResultList()` – execute query returning multiple results

`getSingleResult()` – execute query returning single result

`executeUpdate()` – execute bulk update or delete

`setMaxResults()` – set the maximum number of results to retrieve

`setParameter()` – bind a value to a named or positional parameter

Named Queries

```
@NamedQueries({
    @NamedQuery(name="Sale.findByCustId",
    query="select s from Sale s
           where s.customer.id = :custId
           order by s.salesDate")})

public List<Sale> getSalesByCustomer(int custId) {
 return entityManager.createNamedQuery("Sale.findByCustId")
         .setParameter("custId", custId)
         .getResultList();
}
```

- **Statically** defined queries
- Use **createNamedQuery**() method and pass in the query name already defined in the annotation
- Query names are “globally” scoped
- Get compiled and errors reported at compile time

Dynamic JPQL Queries

- Use **`createQuery()`** method and pass in the JPQL query string at runtime
- Queries can have named parameters that are prefixed with a **colon** (**:**)
- To pass the parameter to the query use method:

```
query.setParameter(String name, Object value)
```

```
public List<Customer> findByName (String name) {
  return em.CreateQuery (
   "SELECT c FROM Customer c " +
   "WHERE c.name LIKE :custName")
   .setParameter("custName", name)
    .getResultList();
}
```

SQL Queries

- Create a SQL query object using **`createNativeQuery()`** method and pass in the SQL query string

```
Query query = em.createNativeQuery("select *
from users where username = ?1",
qu.jpa.User.class);

query.setParameter(1, "shrek");

User user = query.getSingleResult();
```

Why Use JPQL?

- Once the mapping is defined, the programmer, can design the queries by just looking at the java classes
- JPQL isolates you from the mapping logic
  - For example, your object may be mapped into separate tables but you do not bother with the join when writing your query
- JPQL Named Queries are compiled and any errors (such as a missing column) are reported by the compiler
- JPQL makes it less likely that you will be using vendor-specific, non-portable SQL

Summary

JPA emerged from best practices of existing ORM products. It offers:

- ✓ **Standardized object-relational mapping** specified using annotations

- ✓ Simple, lightweight and powerful persistent API
- ✓ Feature-rich query language
- ✓ Support for entity **relationships** and **inheritance**
- ✓ Works for both Java SE and Java EE

Resources

- Java EE Tutorials

http://docs.oracle.com/javaee/7/tutorial/

https://www.youtube.com/playlist?list=PL74xrT3oGQfCCLFJ2HCTR_iN5hV4penDz

- Code examples for '***Java EE 7 Essentials***' book

https://github.com/javaee-samples/javaee7-samples

- JPA Examples

http://wiki.eclipse.org/EclipseLink/Examples/JPA