Exploring the Java Persistence API

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Agenda

- JPA Overview
- Annotating Persistent Entities
- Understanding the EntityManager
- JPQL and the Query Interface
- Spring and JPA
- Demo

JPA Overview

What is the JPA?

- Developed under JSR-220
  - Initial goal was to simplify EJB CMP
- JSR-220 segmented into two specifications:
  - EJB 3.0
  - Java Persistence API
    - Complete, standalone ORM solution for both Java EE and Java SE environments
- Significant Community Involvement:
  - Leverages best ideas from Hibernate, Toplink, and JDO

Why should I care?

- Why not just use JDBC?
  - Low level API
  - Simple to use, but can be error prone
- Why not just use [INSERT ORM HERE]?
  - Standardized API leveraging best ideas from ORM community
  - Better for developers - one API to learn and use
  - Can choose between competing implementations
  - Vendor independence

Goals

- Provide complete ORM solution for Java SE and Java EE environments
- Easy to use
  - Standard POJOs - no framework interfaces or classes to implement or extend
  - Facilitate test-driven development
- Annotation driven, no XML mappings required.
- Configuration By Exception
  - Sensible defaults

JPA Features

- Simple POJO Persistence
  - No vendor-specific interfaces or classes
- Supports rich domain models
  - No more anemic domain models
  - Multiple inheritance strategies
  - Polymorphic Queries
  - Lazy loading of associations
- Rich Annotation Support
- Pluggable persistence providers

Persistent POJOs

POJO Requirements

- Annotated with @Entity
- Contains a persistent @Id field
- No argument constructor (public or protected)
- Not marked final
  - Class, method, or persistent field level
- Top level class
  - Can't be inner class, interface, or enum
- Must implement Serializable to be remotely passed by value as a detached instance

Persistent Entity Example

```
@Entity
public class AppUser {

  @Id
  private Long id;
  private String username;
  private String password;

}
```

AppUser		
id	username	password

Annotating Entities

JPA Annotations

- JPA annotations are defined in the javax.persistence package:
  - http://java.sun.com/javaee/5/docs/api/javax/persistence/package-summary.html
- Annotations can be placed on fields or properties
  - Field level access is preferred to prevent executing logic
  - Property-level annotations are applied to "getter" method
- Can’t mix style in inheritance hierarchy
  - Must decide on field OR property

Persistent Identifiers

- Entities must define an id field/fields corresponding the the database primary key
- The id can either be simple or composite value
- Strategies:
  - @Id: single valued type - most common
  - @IdClass: map multiple fields to table PK
  - @EmbeddedId map PK class to table PK
- Composite PK classes must:
  - implement Serializable
  - override equals() and hashCode()

@IdClass

- Maps multiple fields of persistent entity to PK class

```java
@Entity
@IdClass(ArtistPK.class)
public class Artist {

  @Id
  private Long idOne;
  @Id
  private Long idTwo;
}
```

```java
public class ArtistPK
    implements Serializable {

  private Long idOne;
  private Long idTwo;

  public boolean equals(Object obj);
  public int hashCode();
}
```

@EmbeddedId

- Primary key is formal member of persistent entity

```
@Entity
public class Artist {

   @EmbeddedId
   private ArtistPK key;
}
```

```
@Embedded
public class ArtistPK
    implements Serializable {

   private Long id1;
   private Long id2;

   public boolean equals(Object obj);
   public int hashCode();
}
```

@GeneratedValue

- Supports auto-generated primary key values
- Strategies defined by GenerationType enum:
  - GenerationType.AUTO (preferred)
  - GenerationType.IDENTITY
  - GenerationType.SEQUENCE
  - GenerationType.TABLE

```
@Id
@GeneratedValue(strategy = GenerationType.AUTO)
private Long id;
```

@Table and @Column

- Used to define *name* mappings between Java object and database table/columns
- @Table applied at the persistent class level
- @Column applied at the persistent field/property level

```
@Entity
@Table(name = "TBL_ARTIST")
public class Artist {

   @Id
   @Column(name = "ARTIST_ID")
   private Long id;

   @Column(name = "ARTIST_NAME")
   private String name;
}
```

TBL_ARTIST	
ARTIST_ID	NUMERIC
ARTIST_NAME	VARCHAR(50)

@Temporal

- Used with java.util.Date or java.util.Calendar to determine how value is persisted
- Values defined by TemporalType:
  - TemporalType.DATE (java.sql.Date)
  - TemporalType.TIME (java.sql.Time)
  - TemporalType.TIMESTAMP (java.sql.Timestamp)

```
...
@Temporal(value=TemporalType.DATE)
@Column(name="BIO_DATE")
private Date bioDate;
...
```

TBL_ARTIST	
ARTIST_ID	NUMERIC
BIO_DATE	DATE

@Enumerated

- Used to determine strategy for persisting Java enum values to database
- Values defined by EnumType:
  - EnumType.ORDINAL (default)
  - EnumType.STRING

```
@Entity
public class Album {
   ...
   @Enumerated(EnumType.STRING)
   private Rating rating;
   ...
}
```

ALBUM	
ALBUM_ID	NUMERIC
RATING	VARCHAR(10)

@Lob

- Used to persist values to BLOB/CLOB fields
- Often used with @Basic to lazy load value

```
@Entity
public class Album {
   ...
   @Lob
   @Basic (fetch = FetchType.LAZY)
   @Column(name = "ALBUM_ART")
   private byte[] artwork;
   ...
}
```

ALBUM	
ALBUM_ID	NUMERIC
ALBUM_ART	BLOB

@Version

- JPA has automatic versioning support to assist optimistic locking
- Version field should not be modified by the application
- Value can be primitive or wrapper type of short, int, long or java.sql.Timestamp field

```
@Version
private Integer version;
```

@Transient

- By default, JPA assumes all fields are persistent
- Non-persistent fields should be marked as transient or annotated with @Transient

```
@Entity
public class Genre {

  @Id
  private Long id;                  ← persistent

  private transient String value1;  ← not persistent

  @Transient
  private String value2;            ← not persistent
}
```

@Embedded & @Embeddable

```
@Entity
public class Artist {
   ...
   @Embedded
   private Bio bio;
}
```

```
@Embeddable
public class Bio {

   @Temporal(value=TemporalType.DATE)
   @Column(name="BIO_DATE")
   private Date bioDate;

   @Lob
   @Column(name="BIO_TEXT")
   private String text;
}
```

ARTIST	
ALBUM_ID	NUMERIC
BIO_DATE	DATE
BIO_TEXT	CLOB

Annotating Relationships

Relationships

- JPA supports all standard relationships
  - One-To-One
  - One-To-Many
  - Many-To-One
  - Many-To-Many
- Supports unidirectional and bidirectional relationships
- Supports both composite and aggregate relationships

@OneToOne

- Can be based on shared primary key or foreign key relationship using either @PrimaryKeyJoinColumn or @JoinColumn


```java
@Entity
public class Artist {

   @Id
   private Long id;

   @OneToOne
   @JoinColumn(name = "MANAGER_ID")
   private Manager manager;
}
```

```java
@Entity
public class Manager {

   @Id
   private Long id;

   @OneToOne(mappedBy="manager")
   private Artist artist;
}
```

Specifies relationship based on MANAGER_ID column

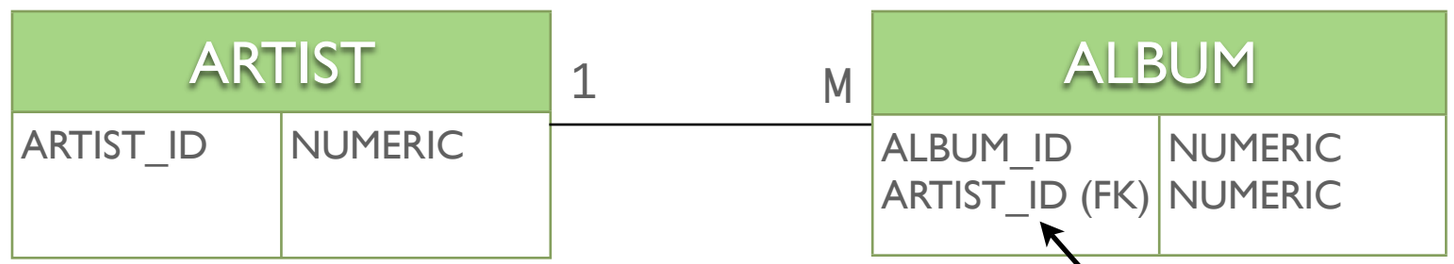
@OneToMany

- @OneToMany defines the *one* side of a one-to-many relationship
- The *mappedBy* element of the annotation defines the object reference used by the *child* entity
- @OrderBy defines an collection ordering required when relationship is retrieved
- The child (many) side will be represented using an implementation of the java.util.Collection interface

@ManyToOne

- @ManyToOne defines the *many* side of a one-to-many relationship
- @JoinColumn defines foreign key reference
- The *many* side is considered to be the owning side of the relationship

One-To-Many Example



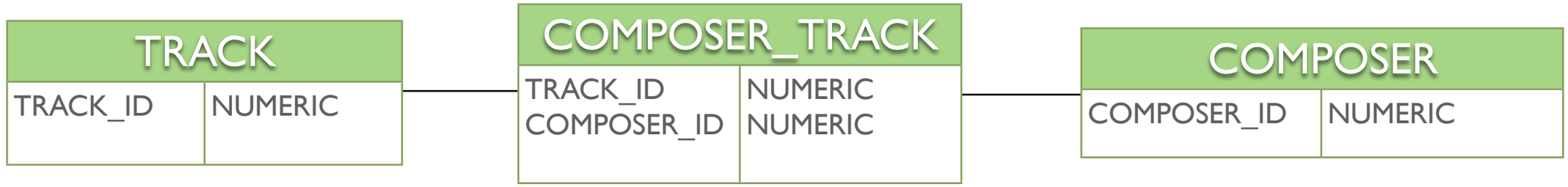

```java
@Entity
public class Artist {

   @Id
   @Column(name = "ARTIST_ID")
   private Long id;

   @OneToMany(mappedBy = "artist")
   private Set<Album> albums =
                 new HashSet<Album>();
}
```

```java
@Entity
public class Album {

   @Id
   @Column(name = "ALBUM_ID")
   private Long id;

   @ManyToOne
   @JoinColumn(name = "ARTIST_ID")
   private Artist artist;
}
```

@ManyToMany

- @ManyToMany annotation is defined on both sides of the relationship
- Each entity contains a collection of the other
- @JoinTable is specified on the *owning* side of the relationship
  - The owning side in a many-to-many is arbitrary
- @JoinColumn is used to specify the *owning* and *inverse* columns of the join table

Many-To-Many Example




```java
@Entity
public class Track {

   @Id
   @Column(name = "TRACK_ID")
   private Long id;

   @ManyToMany(mappedBy="compositions")
   private Set<Composer> composers
               = new HashSet<Composer>();
}
```

```java
@Entity
public class Composer {
   @Id
   @Column(name = "COMPOSER_ID")
   private Long id;

   @ManyToMany
   @JoinTable(name="COMPOSER_TRACK",
   joinColumns = { @JoinColumn(name = "COMPOSER_ID") },
   inverseJoinColumns = { @JoinColumn(name = "TRACK_ID")
   private Set<Track> compositions;
}
```

Cascading Operations

- JPA supports multiple cascade styles
- Defined by the CascadeType enum:
  - CascadeType.PERSIST
  - CascadeType.MERGE
  - CascadeType.REMOVE
  - CascadeType.REFRESH
  - CascadeType.ALL

Understanding The JPA EntityManager

EntityManager

- Provides interface to *Persistence Context*
- Obtained from instance of EntityManagerFactory
  - Manually created in Java SE environment
  - Managed in Java EE or Spring and injects EntityManager instances where needed
- Provides core persistence operations
- Used to obtain Query interface instance
- Provides access to transaction manager for use in Java SE environments

Key EntityManager Methods

- `<T> T find(Class<T> entityClass, Object primaryKey)`
- `<T> T getReference(Class<T> entityClass, Object primaryKey)`
- `void persist(Object entity)`
- `<T> T merge(T entity)`
- `refresh(Object entity)`
- `remove(Object entity)`
- `void flush()`
- `void close();`

Persistence Context & Unit

- A Persistence Context is a collection of persistent entities managed by the Entity Manager
- Persistence Unit is defined in persistence.xml
  - The only XML required by JPA!
  - Must be defined loaded from META-INF directory
- A persistence-unit defines:
  - The persistence context name
  - Data source settings
  - Vendor specific properties and configurations

Example persistence.xml

```xml
<?xml version="1.0" encoding="UTF-8"?>
<persistence> <!-- removed schema info to reduce clutter -->

   <!-- Demo Persistence Unit -->
   <persistence-unit name="jpademo" transaction-type="RESOURCE_LOCAL">

      <jta-data-source>java:/comp/env/jdbc/JpaDemo</jta-data-source>

      <properties>
         <!-- Only scan and detect annotated entities -->
         <property name="hibernate.archive.autodetection" value="class" />
         <!-- JDBC/Hibernate connection properties -->
         <property name="hibernate.dialect" value="org.hibernate.dialect.MySQLDialect" />

         <!-- Set hibernate console formatting options -->
         <property name="hibernate.show_sql" value="true" />
         <property name="hibernate.format_sql" value="true" />
         <property name="hibernate.use_sql_comments" value="false" />

      </properties>
   </persistence-unit>
</persistence>
```

Listeners & Callbacks

- JPA supports lifecycle callback and listener operations.
- Pre/Post operations supported:
  - @PrePersist/@PostPersist
  - @PreUpdate/@PostUpdate
  - @PreRemove/@PostRemove
  - @PostLoad

JPA Queries

Query Interface

- Obtained from the EntityManager using:
  - `createQuery()`
  - `createNamedQuery()`
  - `createNativeQuery()`
- Supports bind parameters, both named and ordinal
- Returns query result:
  - `getSingleResult()`
  - `getResultList()`
- Pagination Support:
  - `setFirstResult()`
  - `setMaxResults()`

JPA Queries

- Supports static & dynamic queries
- Queries can be written using JPQL or SQL
- Named and positional bind parameters
- Supports both static and dynamic queries
  - Static queries are written as annotations of the entity
- Supports eager fetching using the fetch keyword

JPQL Features

- Java Persistence Query Language (JPQL)
  - Extension of EJB QL language
- SQL like syntax
  - Reference objects/properties instead of tables/columns
- Supports common SQL features:
  - Projections
  - Inner & Outer Joins - Eager fetching supported
  - Subqueries
  - Bulk operations (update and delete)

JPQL Examples

Dynamic Query

```
public Album findById(Long id) {
   String jpql = "select distinct a from Album a left join fetch a.artist art "
   + "left join fetch art.genre left join fetch a.tracks where a.id = :id"
   Query query = getEntityManager().createQuery(jpql);
   query.setParameter("id", id);
   return (Album) query.getSingleResult();
}
```

Static Query

```
@NamedQuery(name="artist.all",
        query="select distinct a from Artist a left join fetch a.albums")

public List<Artist> findAll() {
   Query query = getEntityManager().createNamedQuery("artist.all");
   return query.getResultList()
}
```

JPA Demo
Spring & JPA

Spring 2.0's JPA Support

- Supports JPA in both managed and non-managed environments:
  - J2EE/Java EE environments
  - Servlet Containers
- No code or annotation Spring dependencies required
- EntityManagers can be injected using the JPA standard @PersistenceContext annotation
- Transparent transaction management & exception translation
- Additionally offers JpaTemplate & JpaDaoSupport classes
  - Simplified JPA usage, often single line of code

Spring JPA Configuration

```xml
<?xml version="1.0" encoding="UTF-8"?>
<beans>
   <bean id="dataSource" class="org.springframework.jndi.JndiObjectFactoryBean">
      <property name="jndiName" value="java:/comp/env/jdbc/JpaDemo" />
   </bean>

   <bean id="entityManagerFactory"
         class="org.springframework.orm.jpa.LocalContainerEntityManagerFactoryBean">
      <property name="dataSource" ref="dataSource" />
      <property name="jpaVendorAdapter">
         <bean class="org.springframework.orm.jpa.vendor.HibernateJpaVendorAdapter">
            <property name="database" value="MYSQL" />
            <property name="showSql" value="true" />
         </bean>
      </property>
   </bean>

   <bean id="transactionManager" class="org.springframework.orm.jpa.JpaTransactionManager">
      <property name="entityManagerFactory" ref="entityManagerFactory" />
   </bean>

   <bean class="org.springframework.orm.jpa.support.PersistenceAnnotationBeanPostProcessor" />
</beans>
```

Demo

Q & A

Resources

- Java Persistence with Hibernate
  - http://www.manning.com/bauer2/
- JPA 101- Java Persistence Explained
  - http://www.sourcebeat.com/books/jpa.html
- JPA Annotation Reference
  - http://www.oracle.com/technology/products/ias/toplink/jpa/resources/toplink-jpa-annotations.html
- JPA Sample Application
  - http://www.bobmccune.com/