Using the Java Persistence API

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Background

- Part of JSR-220 (EJB 3.0)
- Began as simplification of entity beans
  - Evolved into POJO persistence technology
- Scope expanded at request of community to support general use in Java™ EE and Java SE environments
- Implementations
  - Oracle TopLink Essentials (RI)
  - BEA Kodo / Apache OpenJPA
  - RedHat Hibernate

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Primary Features

- POJO-based persistence model
  - Simple Java classes—not components
- Support for enriched domain modeling
  - Inheritance, polymorphism, etc.
- Expanded query language
- Standardized object/relational mapping
  - Using annotations and/or XML
- Usable in Java EE and Java SE environments
- Support for pluggable persistence providers

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Entities

- Plain old Java objects
  - Created by means of **`new`**
  - No required interfaces
  - Have persistent identity
  - May have both persistent and non-persistent state
    - Simple types (e.g., primitives, wrappers, enums, serializable)
    - Composite dependent object types (e.g., Address)
    - Non-persistent state (transient or @Transient)
  - Can extend other entity and non-entity classes
  - No need for data transfer objects

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Entity Example

```
@Entity
public class Customer implements Serializable {
    @Id @GeneratedValue protected Long id;
    protected String name;
    @Embedded protected Address address;
    protected PreferredStatus status;
    @Transient protected int orderCount;

    public Customer() {}

    public Long getId() {return id;}

    public String getName() {return name;}
    public void setName(String name) {this.name = name;}

    ...
}
```

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Session Bean using an Entity

```
import javax.persistence.*;
import javax.ejb.*;

@Stateless
@Remote(OrderManager.class)
public OrderManagerImpl implements OrderManager {

    @PersistenceContext private EntityManager em;

    public Order newOrderForProduct(long custId,
        long prodId) {
        Customer c = em.find(Customer.class, custId);
        Product p = em.find(Product.class, prodId);

        Order o = new Order(customer);
        em.persist(o);
        o.addLineItem(new Item(p));

        return o;
    }
}
```

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Entity Identity

- Every entity has a persistence identity
  - Maps to primary key in database
- Can correspond to simple type
  - Annotations
    - @Id—single field/property in entity class
    - @GeneratedValue—value can be generated automatically
- Can correspond to user-defined class
  - Annotations
    - @EmbeddedId—single field/property in entity class
    - @IdClass—corresponds to multiple Id fields in entity class
- Must be defined on root of entity hierarchy or mapped superclass

Persistence Context

- Set of managed entity instances at runtime
- Unique entity identity for any persistent identity
- Entity instances all belong to same persistence unit; all mapped to same database
  - Persistence unit is unit of packaging and deployment
- EntityManager API
  - manages persistence context
  - controls lifecycle of entities
  - finds entities by id
  - factory for queries

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Persistence Context

- Entity becomes managed
- Entity becomes persistent in db at commit time

```
@Stateless public class OrderManagementBean
    implements OrderManagement {
    …
    @PersistenceContext EntityManager em;
    …
    public Order addNewOrder(Customer customer,
                             Product product) {

        Order order = new Order(product);
        customer.addOrder(order);
        em.persist(order);
        return order;
    }
}
```

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Relationships

```
@Entity public class Customer {
    @Id protected Long id;
    …
    @OneToMany protected Set<Order> orders = new HashSet();
    @ManyToOne protected SalesRep rep;
    …
    public Set<Order> getOrders() {return orders;}
    public SalesRep getSalesRep() {return rep;}
    public void setSalesRep(SalesRep rep) {this.rep = rep;}
}

@Entity public class SalesRep {
    @Id protected Long id;
    …
    @OneToMany(mappedBy="rep")
    protected Set<Customer> customers = new HashSet();
    …
    public Set<Customer> getCustomers() {return customers;}
    public void addCustomer(Customer customer) {
        getCustomers().add(customer);
        customer.setSalesRep(this);}
}
```

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Cascading persist

```
@Entity
public class Customer {
    @Id protected Long id;
    ...
    @OneToMany(cascade=PERSIST)
    protected Set<Order> orders = new HashSet();
}

...
public Order addNewOrder(Customer customer, Product
product) {

    Order order = new Order(product);
    customer.addOrder(order);
    return order;
}
```

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Queries

- Static queries
  - Defined in Java annotations or XML
- Dynamic queries
- Use JPQL or SQL
- Named or positional parameters
- EntityManager is factory for Query objects
  - createNamedQuery, createQuery, createNativeQuery
- Query methods for controlling max results, pagination, flush mode

Dynamic Query

```
@PersistenceContext EntityManager em;

...
public List findByZipcode(int zip) {
    return em.createQuery ("SELECT p FROM Person p "
        + "WHERE p.address.zip = :zipcode")
    .setParameter("zipcode", zip)
    .setMaxResults(20)
    .getResultList();
}
```

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Named Query

```
@NamedQuery(name="Person.findByZipcode", query =
"SELECT p FROM Person p WHERE p.address.zipcode = :zip")
@Entity public class Person { ... }
```

```
public List findPersonByZipcode(int zipcode) {
    return em.createNamedQuery ("Person.findByZipcode")
    .setParameter("zip", zipcode)
    .setMaxResults(20)
    .getResultList();
}
```

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JP QL

- An extension of EJB QL
  - Like EJB QL, a SQL-like language
- Added functionality
  - Projection list (SELECT clause)
  - Explicit JOINS
  - Subqueries
  - GROUP BY, HAVING
  - EXISTS, ALL, SOME/ANY
  - UPDATE, DELETE operations
  - Additional functions

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JP QL Examples

```
SELECT e FROM Employee e WHERE e.status = :stat

SELECT e.name, d.name
    FROM Employee e JOIN e.department d
    WHERE e.status = 'FULLTIME'

SELECT new com.example.EmployeeInfo(e.id, e.name,
        e.salary, e.status, d.name)
    FROM Employee e JOIN e.department d
    WHERE e.address.state = 'CA'

SELECT DISTINCT o
    FROM Invoice i JOIN o.lineItems l JOIN l.product p
    WHERE p.productType = 'shoes'

UPDATE Employee e
    SET e.salary = e.salary * 1.1
    WHERE e.department.name = 'Engineering'
```

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O/R Mapping

- Map persistent object state to relational database
- Map relationships to other entities
- Mapping metadata may be annotations or XML (or both)
- Annotations
  - Logical—object model (e.g., @OneToMany, @Id, @Transient)
  - Physical—DB tables and columns (e.g., @Table, @Column)
- XML
  - Elements for mapping entities and their fields or properties
  - Can specify metadata for different scopes
- Rules for defaulting of database table and column names

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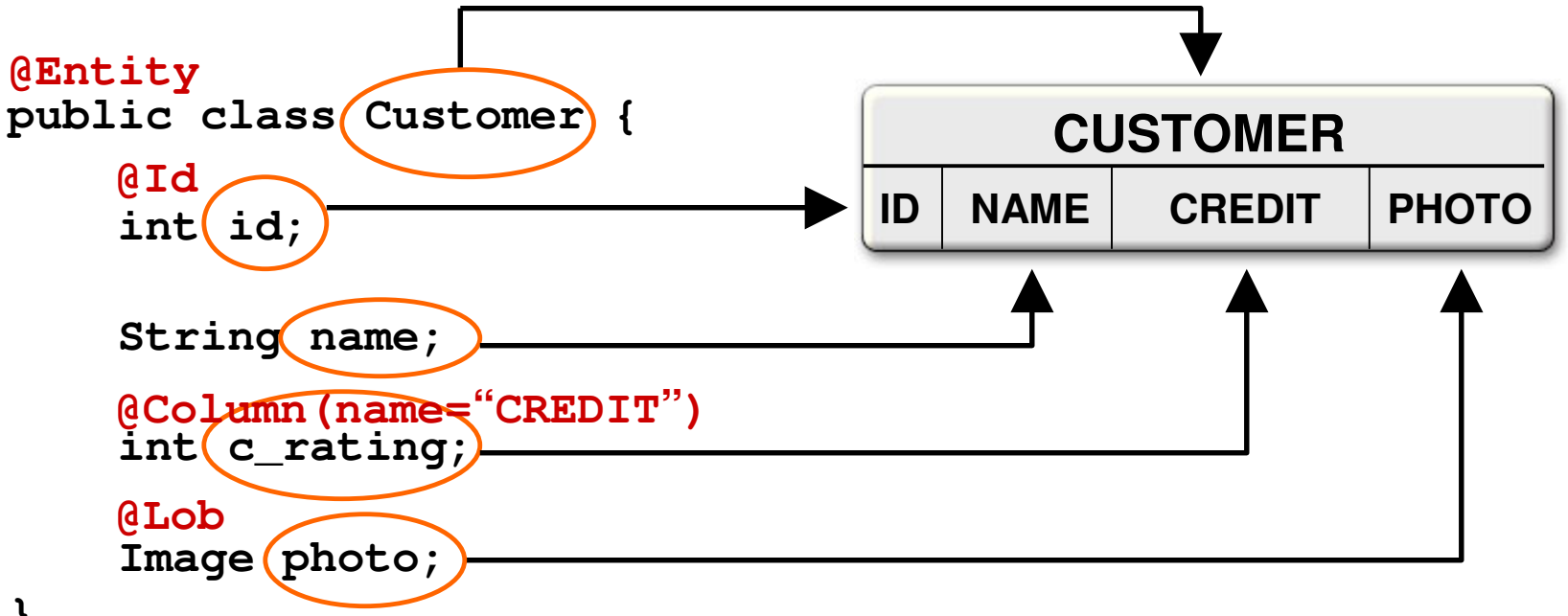
O/R Mapping

- State or relationships may be loaded or "fetched" as EAGER or LAZY
  - LAZY is a hint to the Container to defer loading until the field or property is accessed
  - EAGER requires that the field or relationship be loaded when the referencing entity is loaded
- Cascading of entity operations to related entities
  - Setting may be defined per relationship
  - Configurable globally in mapping file for persistence-by-reachability

Simple Mappings



Simple Mappings

```
<entity class="com.acme.Customer">
  <attributes>
    <id name="id"/>
    <basic name="c_rating">
      <column name="CREDIT"/>
    </basic>
    <basic name="photo"><lob/></basic>
  </attributes>
</entity>
```

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Persistence Unit

- Set of entities and related classes that share the same configuration
- Convenient packaging and deployment unit
- Runtime configuration defined in persistence.xml
- Can reference additional classes on classpath or additional jar
- One or more O/R mapping files
- Scoping boundary for queries and id generators

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Example

```
<persistence>
  <persistence-unit name="OrderMgmt">
    <provider>com.acme.PersistenceProvider</provider>
    <jta-data-source>jdbc/MyOrderDB</jta-data-source>
    <mapping-file>order-mappings.xml</mapping-file>
    <jar-file>myparts.jar</jar-file>
    <properties>
      <property
        name="com.acme.persistence.logSQL"
        value="ALL"/>
    </properties>
  </persistence-unit>
</persistence>
```

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Configuration

- One XML file: META-INF/persistence.xml

```
<persistence>
  <persistence-unit name="OrderManagement">
    <jta-data-source>jdbc/MyOrderDB</jta-data-source>
    <mapping-file>ormap.xml</mapping-file>
  </persistence-unit>
</persistence>
```

- May define multiple units in same XML file
- Persistence provider is automatically located if not specified in XML
  - Container's choice in container
  - Classpath order outside a container
- Entity types are auto-detected by the container

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Transactions

- EntityManagers are configured to be of a particular transaction type
  - Global JTA transactions – the most common
  - Private or 'resource-local' JDBC-style transactions
- JTA transactions
  - Used by either container-managed or application-managed EntityManagers
  - Demarcated externally to the EM (either by Container or application)
- Resource-local transactions
  - Only in application-managed EntityManagers
  - Demarcated by invoking on the EM

Entity Transactions

- Resource-level transaction akin to a JDBC transaction
- Isolated from transactions in other EntityManagers
- Transaction demarcation under explicit application control using EntityTransaction API
  - begin(), commit(), setRollbackOnly(), rollback(), isActive()
- Underlying (JDBC) resources allocated by EntityManager as required

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Java SE Example

```
EntityManagerFactory emf =
   Persistence.createEntityManagerFactory("orders");
EntityManager em = emf.createEntityManager();
em.getTransaction().begin();

try {
    Collection<Customer> customers = loadCustomersFromFile
        (new File("nightly-upload.csv"));
    for (Customer customer : customers)
        em.persist(customer);
    em.getTransaction().commit();
} finally {
    if (em.getTransaction().isActive())
        em.getTransaction().rollback();
}
em.close();
emf.close();
```

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Detached Entities

- Instances become detached when
  - the persistence context ends
  - upon serialization
- Detached entities can be accessed and modified either in the current VM or in another VM
- Changes to detached instances can be merged into the original persistence context or a different one

```
void updatePerson(Person personDTO) {
    Person p = em.merge(personDTO);
    p.setLastUpdated(new Date());
}
```

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Detached Entities

- Detached instances are useful for transfer to a different physical tier
  - Must implement java.io.Serializable
- Represent a conversion from the persistent domain to the data transfer domain
- May only access loaded state

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Optimistic Locking

```
@Entity
public class Employee {
  @Id @GeneratedValue private long pk;
  @Version private int oplock;
  private String name;
}
```

- JPA currently does not standardize pessimistic locking
- Version field is maintained by the persistence provider
- “Offline Optimistic Lock” pattern is automatically handled by JPA detachment
- Bulk updates require manual lock field increment (or vendor-specific feature)

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Releases

- Final Release part of EJB 3.0, which is part of Java EE 5.0
- JPA specification available at http://jcp.org/en/jsr/detail?id=220
- Popular Implementations
  - Oracle TopLink Essentials (RI)
  - BEA Kodo / Apache OpenJPA
  - RedHat Hibernate

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Summary

- Entities are simple Java classes
  - Easy to develop and intuitive to use
  - Can be moved to other server and client tiers
- EntityManager
  - Simple API for operating on entities
  - Supports use inside and outside Java EE containers
- Standardization
  - O/R mapping using annotations or XML
  - Named and dynamic query definition
  - SPI for pluggable persistence providers

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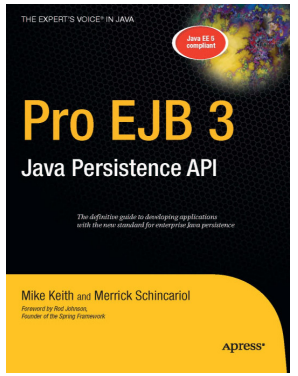
For More Information

- Resources
  - http://dev2dev.bea.com/persistence
  - http://incubator.apache.org/projects/openjpa
  - http://otn.oracle.com/jpa
  - michael.keith@oracle.com
  - patrick.linskey@bea.com
- Books
  - Pro EJB 3: Java Persistence API

    Mike Keith & Merrick Schincariol
    (Foreword by Rod Johnson)



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