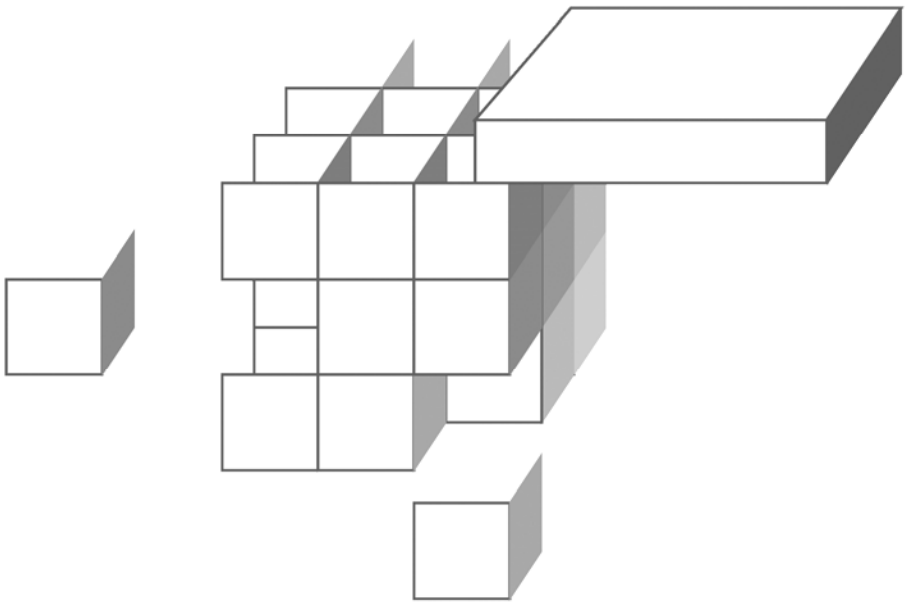
Chapter 5
The Criteria Query API



OBJECTIVES

After completing "The Criteria Query API," you will be able to:

- Build **Criteria** queries.
- Use criteria restrictions.
- Illustrate sorting techniques.
- Work with projections and aggregations.
- Demonstrate Query by Example (QBE).

Criteria Queries

- **Hibernate provides three different ways to retrieve data:**
  - The **Criteria API**, which is discussed in this chapter.
  - The **Hibernate Query Language**, which is the subject of the next chapter.
  - **Native SQL** queries, which can be used in HQL expressions.
- **The Criteria API allows queries to be built at runtime without direct string manipulations.**
- **A Criteria object is a tree of Criterion instances, which are Java objects used to construct queries.**
- **The Criteria query API also includes Query by Example (QBE) functionality for supplying example objects.**
- **Criteria also includes projection and aggregation methods, such as count.**
- **Since criteria queries are built from library objects, the queries are parsed and validated at compile time, unlike Hibernate Query Language strings.**

The Criteria Interface

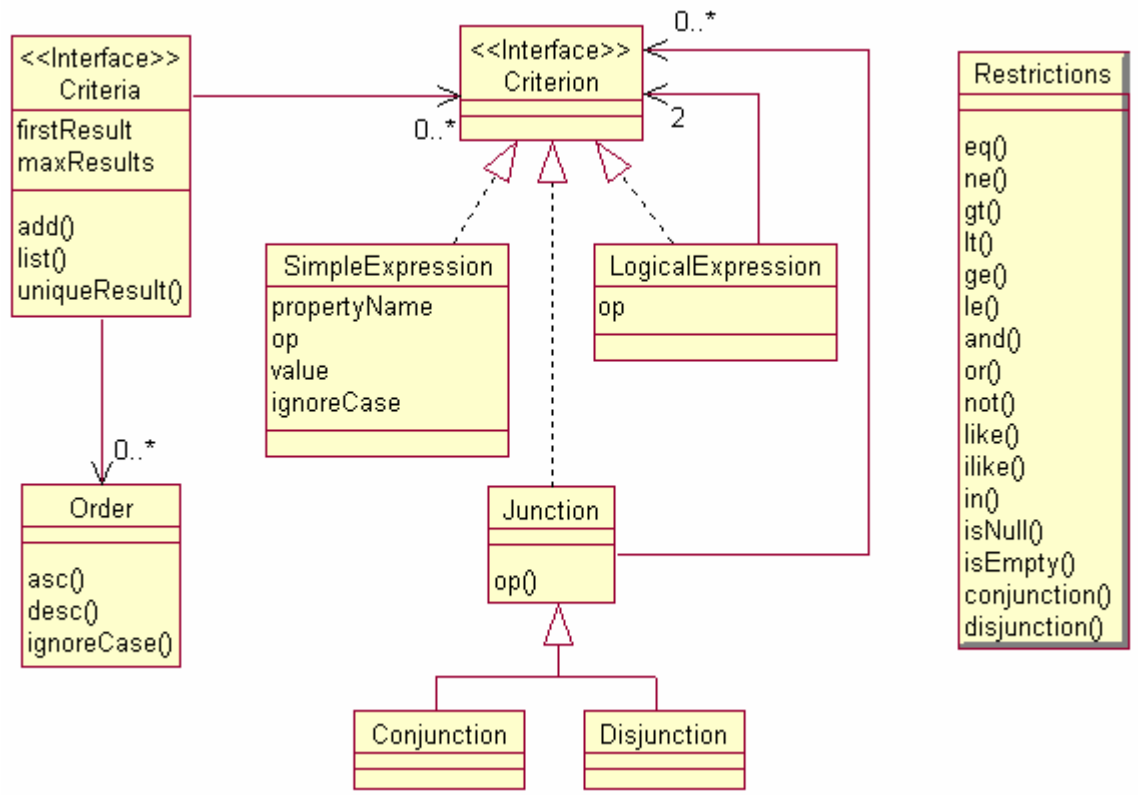
- The **Criteria** interface is in the **org.hibernate** package.
- It is a very convenient approach for applying a variable number of conditions to a search.
- Since **Criteria** is an interface, it can't be instantiated. Instead, the **Session** class has a factory method called **createCriteria**, which takes a reference of type **Class**.

```
Criteria crit = session.createCriteria(User.class);
```

  - In fact there are several overloads of **createCriteria** in **Session**, which allow an entity name or an alias to be specified.
  - The form that takes a **Class** reference is the most common, however.
- As with most Hibernate classes, the methods in **Criteria** return the **this** reference, so additional calls can be chained.

The Criteria API

- **The following UML diagram summarizes the fundamentals of the Criteria API:**



  - Queries primarily comprise **Criterion** instances, which say what objects to select.
  - They can be ordered using **Order** instances.
  - A query can be defined with **windowing**, including the index of the first row to return and the number of results to fetch.

The Restriction Class Utility

- The **Restrictions** class is a static factory for **Criterion** instances.
- As an example, to find a **User** by name:

```
Criteria crit = session.createCriteria(User.class);
crit.add( Restrictions.eq("name", "buffy") );
User buffy = (User) crit.uniqueResult();
```

- Using method chaining, this becomes

```
User buffy =
  (User) session.createCriteria(User.class)
  .add(Restrictions.eq("name","buffy"))
  .uniqueResult();
```

- The **org.hibernate.criterion.Restrictions** class is the new name for the **net.sf.hibernate.expression.Expression** class in Hibernate 2.1.
  - The JavaDoc API for the **Expression** class says, "This class is semi-deprecated. Use **Restrictions**."
- The **Restrictions** class has a large number of static factory methods that return instances of **Criterion**.

The Restriction Class Utility

- Criteria created using only a class name will provide all instances of that class when **list** is called.

```
List<User> users =
  session.createCriteria(User.class).list();
```

  - Using Java-5 generics in this manner will generate a warning message about unchecked casts.

- The factory methods in **Restrictions** allow developers to assemble complex expressions in an object-oriented way.
- Restrictions are applied to a Criteria object using the **add** method.

```
public Criteria add (Criterion restriction);
```

  - Multiple **add** calls are enforced as **boolean AND** conditions.

- The **addOrder** method can be used to order the results.

```
public Criteria addOrder(Order order);
```

  - The **Order** class has two static methods, **asc** and **desc**, which apply ascending or descending ordering constraints using a specified property as an input argument.

```
List emps = session.createCriteria(Employee.class)
  .addOrder( Order.asc("lastName") )
  .list();
```

- Criteria instances can also be chained to make subqueries. This is discussed further below.

The Restriction Class Utility

- A sampling of the methods in the **Restrictions** class includes:
  - **Restrictions.eq**, which applies an equality constraint to the named property.

```
crit.add( Restrictions.eq("lastName","Bigboote") );
```

  - **Restrictions.ge** applies a greater-than-or-equal-to constraint. The methods **gt**, **lt**, **le** are similar for greater-than, less-than, and less-than-or-equal-to.

```
crit.add( Restrictions.gt("salary",50000.0) );
```

  - **Restrictions.like** and **Restrictions.ilike** apply SQL pattern matching constraints, where **ilike** is a case-insensitive version of like. Use the **%** character as a wildcard to match parts of a string.

```
crit.add( Restrictions.ilike("lastName","Ca%") );
```

  - **Restrictions.isNull** and **Restrictions.isNotNull** apply **null** and **not null** constraints on individual fields.

```
crit.add( Restrictions.isNotNull("email") );
```

  - **Restrictions.between** looks for values between two limits, and **Restrictions.in** looks for values contained in a provided collection.

```
crit.add(
  Restrictions.in("address.state",
    new String[]{"CT","GA","VA"}) );
```

Other Restrictions

- **Applying more than one Criterion using Criteria.add requires them both equally, using a boolean AND operator.**
- **In order to apply an OR condition, Restrictions has an or method, which combines two Criterion conditions.**
- **Conditions can be combined using Restrictions.disjunction and Restrictions.conjunction.**
  - No arguments are passed to either method.
  - Criterion instances are then added to the **conjunction** or **disjunction** using their respective **add** methods.
  - The **conjunction** or **disjunction** is then added to a **Criteria** instance and evaluated.

Conjunction and Disjunction

EXAMPLE

- As an example, see **Examples/Earthlings/Step7**, which holds a new class **CriteriaQueries**.
  - Run this example as follows; the output includes the results of several Criteria API queries.

```
run cc.db.hibernate.CriteriaQueries
```

- The method **testConjunction** constructs a conjunction:

```
Criteria crit = s.createCriteria(Employee.class);
Criterion name =
  Restrictions.like("lastName", "Ca%");
Criterion salary =
  Restrictions.gt("salary", 30000.0);
Criterion state = Restrictions.in("address.state",
  new String[] {"MA","NC"});
Conjunction cj = Restrictions.conjunction();
cj.add(name);
cj.add(salary);
cj.add(state);
crit.add(cj);
List<Employee> emps = crit.list();
```

  - Note the usage of the **address** component in **Employee**.

- The result of this query is:

```
Walker Calhoun $38,000.00 MA
Hugh Campbell $32,000.00 MA
King Cardenas $84,000.00 NC
Mariana Castillo $67,000.00 NC
```

- In this case, the three restrictions could have been added directly to the criteria using its **add** method; see the **testMultipleCriteria** method. Either approach is acceptable.

Conjunction and Disjunction

EXAMPLE

- Going the other way, the restrictions can be added to a disjunction instead.
- See the **testDisjunction** method:

```
Criteria crit = s.createCriteria(Employee.class);
Criterion name =
  Restrictions.like("lastName", "Ca%");
Criterion salary =
  Restrictions.gt("salary", 30000.0);
Criterion state =
  Restrictions.in("address.state",
    new String[] {"MA","NC"});

Disjunction dj = Restrictions.disjunction();
dj.add(name);
dj.add(salary);
dj.add(state);
crit.add(dj);
List<Employee> emps = crit.list();
```

  - In this case, many more (actually, 101) **Employees** are matched, since each row only needs to satisfy one of the restrictions.

```
Patrick Acosta $61,000.00 GA
Letitia Anderson $21,000.00 MA
...
Hubert Young $50,000.00 NC
Rebecca Zimmerman $97,000.00 MA
Total: 101
```

Windowing Results

- The Criteria API can be used to retrieve a limited **window** of results from a large result set.
- The **setMaxResults** method limits the total number returned.

```
crit.setMaxResults(10);
```

- The **setFirstResult** method takes an integer to indicate the starting row.

```
crit.setFirstResult(i*10) // i counts windows
```

- Each window results in a separate query.

Printing Employees in Windows

EXAMPLE

- **CriteriaQueries** also includes a method **printWindowedResults**, as follows:

```
Criteria crit =
    session.createCriteria(Employee.class);
crit.setMaxResults(10);

int k = 0;
for (int i = 0; i < 20; i++) {

  crit.setFirstResult(i*10);
  List<Employee> emps = crit.list();

  if (emps.size() == 0) break;
  System.out.println("\nResults from " +
    (i*10) + " to " + (i*10 +emps.size() -1));
  for (Employee e : emps) {
    System.out.println(k++ + ": " + e);
  }
}
```

  - This loop prints the **Employee** instances in groups of 10.
  - Each group results in a SQL **SELECT** statement.

```
Results from 0 to 9
0: Acosta
1: Amdell
2: Anderson
3: Angel
4: Ayer
5: Bailey
6: Barrell
7: Baxter
8: Beard
9: Berger
...
```

Sorting Query Results

- As mentioned above, the **Order** class can be used to sort results.
- **Order** has two static methods, each of which take a **String** property as an argument.

```
public static Order asc(String propertyName);
public static Order desc(String propertyName);
```

- Each is applied through the **addOrder** method in **Criteria**.
- Multiple ordering conditions can be applied. The results will be sorted by the first order, then by the second, and so on.

Associations

EXAMPLE

- Constraints on associations are applied by chaining **Criteria**.
- For example, in the **Earthlings** schema, an **Employee** is a member of a **Department** which has a given **Location**.
  - So, to find all employees that work in Massachusetts, it is necessary to traverse the **Employee** association from its **Department** to the associated **Location**.
  - See **printEmpsWorkInMA**:

```
Criteria crit = s.createCriteria(Employee.class)
  .createCriteria("department")
  .createCriteria("location")
  .add( Restrictions.eq("state", "MA") );

List<Employee> emps = crit.list();

for (Employee e : emps) {
  System.out.println(e.getLastName() + " works for "
    + e.getDepartment().getName() + " in "
    + e.getDepartment().getLocation().getState());
}
```

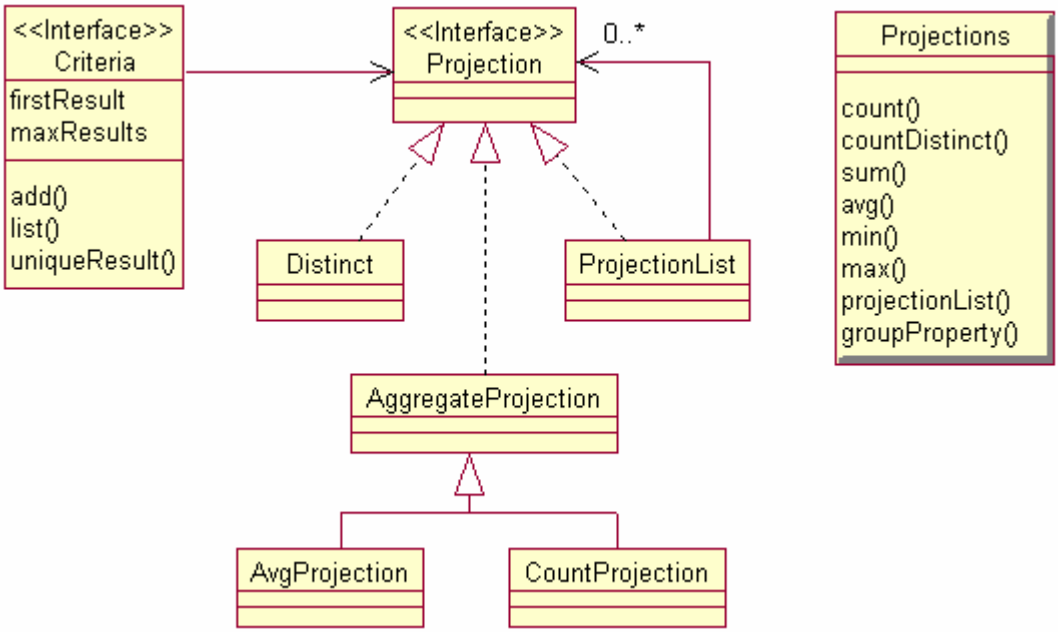
  - The result gives the 22 employees that work in Massachusetts.

```
Anderson works for Administration in MA
Baxter works for Administration in MA
…
Rollins works for Facilities in MA
Watts works for Facilities in MA
```

- By default, the employees are sorted alphabetically by department and within each department by last name. This can easily be modified using the **Order** methods above.

Projections and Aggregates

- Each of the above queries has functioned in terms of objects.
- Instead, the results can be interpreted using **projections**, **aggregate functions**, and **group by** functionality.



The Projections Class Utility

- Projections come from the **org.hibernate.criterion.Projections** factory class.
- As simple example of a projection is counting rows.

```
Criteria crit = s.createCriteria(Employee.class);
crit.setProjection( Projections.rowCount() );
List results = crit.list();
```

- The result list contains a single Integer with the results. This is equivalent to a **COUNT**(*) function in SQL.
- Other available aggregate functions are:

```
public static AggregateProjection avg(String);
public static CountProjection count(String);
public static CountProjection
  countDistinct(String);
public static AggregateProjection min(String);
public static AggregateProjection max(String);
```

The ProjectionList Class

- More than one projection can be applied to a criteria instance.
- The result is a **List** with an **Object** array as its first element. The array contains all the resulting values in the order requested.
- To add multiple projections, the **Projections** class has a method called **projectionList** that returns an instance of the **ProjectionList** class.

```
public static ProjectionList projectionList();
```

- The **ProjectionList** class has an **add** method that takes a **Projection** as an argument.

```
public ProjectionList add(Projection);
```

- Finally, the projection list is added to a **Criteria** through the **setProjection** method.

```
public Criteria setProjection(Projection proj);
```

Multiple Projections

EXAMPLE

- The method **printMultipleProjections** shows how to set up and execute multiple projections. The key lines of code are:

```
Criteria crit = s.createCriteria(Employee.class);
List results = crit.setProjection(
  Projections.projectionList()
    .add(Projections.rowCount())
    .add(Projections.avg("salary"))
    .add(Projections.min("salary"))
    .add(Projections.max("salary")))
  .list();
Object[] res = (Object[]) results.get(0);
for (Object o : res) {
  System.out.println(o);
}
```

- The generated SQL is then:

```
select
  count(*) as y0_,
  avg(this_.salary) as y1_,
  min(this_.salary) as y2_,
  max(this_.salary) as y3_
from
  EARTHLINGS.EMPLOYEES this_
```

- ... and the printed results are:

```
Row count: 135
Average salary: $43,866.67
Minimum salary: $15,000.00
Maximum salary: $120,000.00
```

  - The returned **List** contains only an **Object** array which has the desired answers in the order they were requested.

Property Projections

EXAMPLE

- Projections can be used to retrieve individual properties rather than entire objects.
- The Projections class has a **property** method takes a **String** property name as an argument and returns a **PropertyProjection**.

```
public static PropertyProjection property(String);
```

- As before, add the resulting projection to projection list, which is then set on a **Criteria**.
- The result is a **List** containing an **Object** array for each row in the result set. See **printProjectionsWithProperties**:

```
Criteria crit = s.createCriteria(Employee.class);
List results = crit.setProjection(
  Projections.projectionList()
    .add(Projections.property("firstName"))
    .add(Projections.property("lastName"))).list();
for (Object o : results) {
  Object[] names = (Object[]) o;
  System.out.println(names[0] + " " + names[1]);
}
```

  - The result shows the first and last names of each **Employee**:

```
Patrick Acosta
...
Rebecca Zimmerman
```

- Property projections are useful when the number of columns in a table is very large, or when a large set of joins may return a very large result set and you're only interested in a few columns.

Group By

EXAMPLE

- The **Projections** class has a method called **groupProperty** that takes a string property name.
- This is equivalent to the **GROUP BY** clause in SQL.
- For example, to count how many employees live in each state, use the following expression.
  - See **projectionWithGroupBy**:

```
List output = s.createCriteria(Employee.class)
  .setProjection(Projections.projectionList()
  .add(Projections.rowCount())
  .add(Projections.groupProperty("address.state")))
  .list();
for (Object o : output) {
  System.out.println(Arrays.asList((Object[]) o));
}
```

- The grouped results are found at the bottom of the program output:

```
Number of employees in each department
[32, GA]
[22, MA]
[46, NC]
[35, NJ]
```

Query By Example

- **Query By Example** provides another style of searching.
- Rather than build a query by programmatically adding conditions to a **Criteria** object, partially populate an instance of the desired object.
  - The partially populated instance is an example.
  - Hibernate then builds the **Criteria** query from the example.
- To convert an object into an example, use the create method in the **org.hibernate.criterion.Example** class.

```
public static Example create(Object entity);
```

- The trick with QBE is that when the query is translated into SQL, all properties of the example that are not null are used in the query.
  - To drop a property from the list, use the **excludeProperty** method.
  - For numerical properties, use the **excludeZeros** method.
- **Example** also has the **ignoreCase** method, which does what it sounds like, and the **enableLike** method, which is used for string comparisons.

Employees in Massachusetts

EXAMPLE

- The following code is used to find all Employees who live in the state of Massachusetts.

```
Criteria crit = s.createCriteria(Employee.class);
Employee ex = new Employee();
Address addr = new Address();
addr.setState("MA");
ex.setAddress(addr);

crit.add(Example.create(ex).excludeZeroes());

List<Employee> emps = crit.list();
for (Employee e : emps) {
  System.out.println(e);
}
System.out.println(emps.size() + " found");
```

- Without using **excludeZeroes**, the result set would be empty. This is because the example employee has a **salary** attribute and a **commissionPct** attribute, each with value zero.

QBE and Associations

EXAMPLE

- QBE associations are done the same way **Criteria** associations were implemented above.
- For example, to find all **Departments** that are located in Massachusetts, we need to follow the association from **Department** to **Location**.
  - See **printDeptsInMAUsingQBE**:

```
Department dept = new Department();
Location loc = new Location();
loc.setState("MA");

List<Department> depts =
  s.createCriteria(Department.class)
    .add(Example.create(dept))
    .createCriteria("location")
      .add(Example.create(loc))
  .list();

for (Department d : depts) {
  System.out.println(d.getName() + " "
    + d.getLocation().getState());
```

- The result is:

```
Administration MA
HR MA
Facilities MA
```

Criteria Queries

LAB 5

Suggested time: 30 minutes

In this lab you will create **Criteria** queries to answer various questions about the **Earthlings** database.

Detailed instructions are found at the end of the chapter.

SUMMARY

- The **Criteria** Query API provides an object-oriented way to build complex queries.
- **Criteria** queries begin with the **createCriteria** factory method in the **Session** class. Of its overloads, the most commonly used takes a **Class** reference as an argument.
- The **list** method and the **uniqueResult** method return all instances of a class and a single instance, respectively.
- Constraints on a query are applied using static factory methods from the **Restrictions** class.
- Commonly used **Restrictions** include **eq**, **ne**, **gt**, **lt**, **like**, and **between**. Many variations are available.
- **Projections** are used to compute scalar quantities from results, like **count**, **max**, or **min**.
- Projections can be applied to properties, associations, and more.
- The Query by Example capability lets Hibernate construct a query based on a sample object.

Criteria Queries

LAB 5

In this lab you will create **Criteria** queries to answer various questions about the **Earthlings** database.

Lab workspace: **Labs/Lab5**

Backup of starter code: **Examples/Earthlings/Step7**

Answer folder(s): **Examples/Earthlings/Step8**

Files: **src/cc/db/hibernate/CriteriaLab.java**

Instructions:

Open the file **CriteriaLab.java**. This class has an execute method that demarcates a transaction. In the transaction, call **private** methods that you create in order to answer the following questions using the **Criteria** API.

1. How many **Employee** instances are in the database?
2. What are the names of the **Employees** in the **Administration** department?
3. What is the **Location** of the **Research** department?
4. What is the average **salary** of **Employees** in the **Research** department?
5. What query finds the **Employees** sorted by last name?