- Java [[Object-Relational Mapping]] tool
- entity classes are defined via
  - annotations

Entity Classes

- **Define persistent classes** via annotations
- Add details for IDs, relationship types, and specific behavior on updates
- Some JPA implementations require enhancement process as post compilation step

```
@Entity
public class Student {
   @Id
   private int SID = -1;
   private String Fname;
   private String Lname;
   @ManyToMany
   private List<Course> ...
}
```

  - [[XML]] files

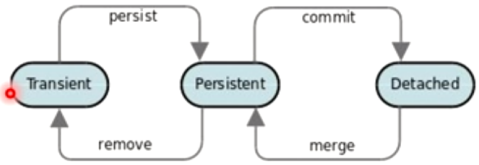
Persistence Definition

- **Separate XML meta data** `META-INF/persistence.xml`
- Includes connection details

```
<?xml version="1.0" encoding="UTF-8" ?>
<persistence
      xmlns="http://xmlns.jcp.org/xml/ns/persistence"
      xmlns:xsi=... xsi:schemaLocation=...>
   <persistence-unit name="UniversityDB">
      <class>org.tugraz.Student</class>
      <class>org.tugraz.Course</class>
      <exclude-unlisted-classes/>
      <properties> ... </properties>
   </persistence-unit>
</persistence>
```

- object modification

- **CRUD Operations**
  - Insert by making objects persistent
  - Update and delete objects according to object lifecycle states
- **Lifecycle States**
  - Lifecycle state transitions via specific persistence contexts
  - Explicit and implicit transitions




```
EntityManager em = factory
   .createEntityManager();

tx.begin();

Student s = new
   Student(7,"Jane","Smith");
s.addCourse(new Course(...));
s.addCourse(new Course(...));

em.persist(s);

tx.commit();
em.close
```

- some ORM tools have special query languages
  - based on SQL

JPQL: Java Persistence Query Language

- SQL-like object-oriented query language
- Parameter binding similar to embedded SQL

```
EntityManager em = factory
   .createEntityManager();
Query q = em.createQuery(
   "SELECT s FROM Student s
      WHERE s.age > :age");
q.setParameter("age", 35);

Iterator iter = q
   .getResultList().iterator();
while( iter.hasNext() )
   print((Student)iter.next());
```

- programmatic APIs exist as well

JPQL Criteria API

- JPQL syntax and semantics with a programmatic API

```
CriteriaQuery<Student> q = bld.createQuery(Student.class);
Root<Student> c = q.from(Student.class);
q.select(c).where(bld.gt(c.get("age"), bld.parameter(...)));
```

```
.getResultList().iterator();
while( iter.hasNext() )
  print((Student)iter.next());
```

- sometimes native SQL queries still necessary
  - API not sufficient enough

JDBI

- Java Database Interface

Jdbi Overview

- Fluent API built on top of JDBC w/ same functionality exposed
- Additional simplifications for row to object mapping

Example

```
Jdbi jdbi = Jdbi.create("jdbc:postgresql://.../db1234567");
Handle handle = jdbi.open();

jdbi.registerRowMapper(Student.class, (rs, ctx)
  -> new Student(rs.getInt("sid"), rs.getString("lname"));

List<Student> ret = handle
  .createQuery("SELECT * FROM Students WHERE LName = :name")
  .bind(0, "Smith")
  .map(Student.class)
  .list();
```