Problem area

- When working with object-oriented systems, there's a mismatch between the *object model* and the *relational database*
- How do we map one to the other?

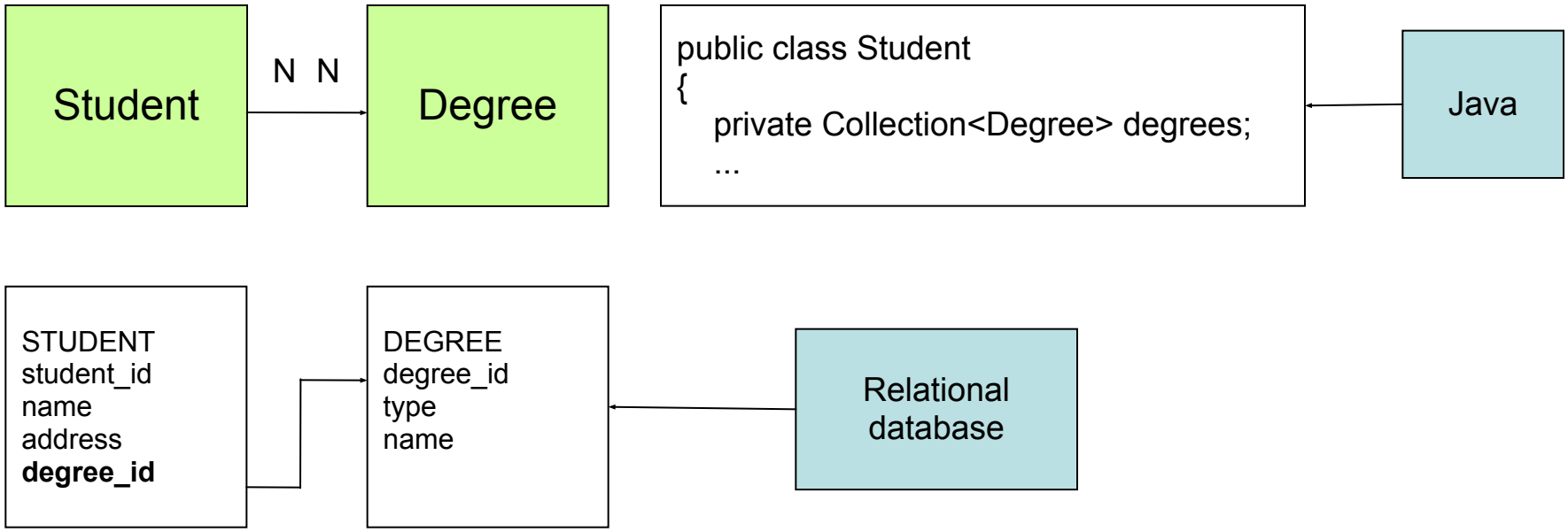
```
public class Student
{
    private String name;
    private String address;
    private Set<Course> courses;
    private Set<Degree> degrees;
}
```

Java object with properties and associations

Relational database with tables and columns

Problem area

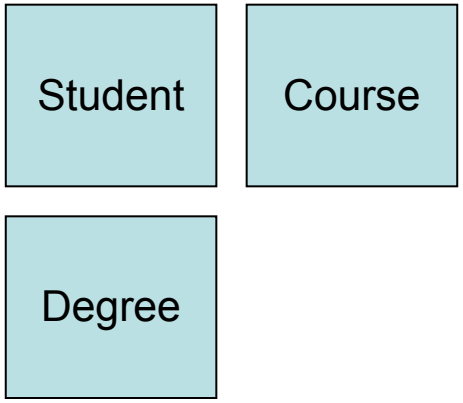
- How to map associations between objects?
  - References are directional, foreign keys not
  - Foreign keys can’t represent many-to-many associations



Need for ORM

- Write SQL conversion methods by hand using JDBC
  - Tedious and requires lots of code
  - Extremely error-prone
  - Non-standard SQL ties the application to specific databases
  - Vulnerable to changes in the object model
  - Difficult to represent associations between objects

```
public void addStudent( Student student )
{
    String sql = ”INSERT INTO student ( name, address ) VALUES ( ’” +
        student.getName() + ”’, ’” + student.getAddress() + ”’ )”;

    // Initiate a Connection, create a Statement, and execute the query
}
```



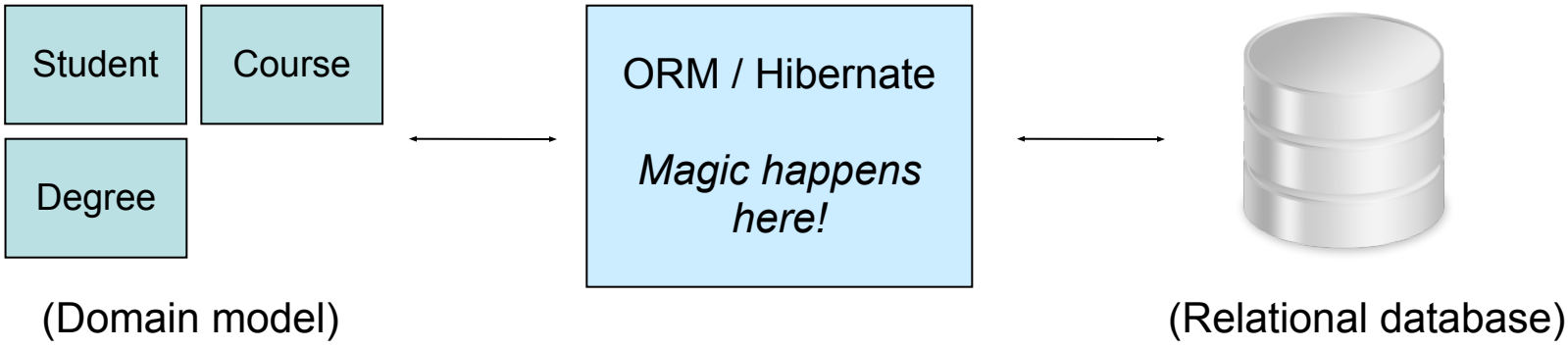
Approaches to ORM

- Use Java serialization – write application state to a file
  - Can only be accessed as a whole
  - Not possible to access single objects

- Object oriented database systems
  - No complete query language implementation exists
  - Lacks necessary features

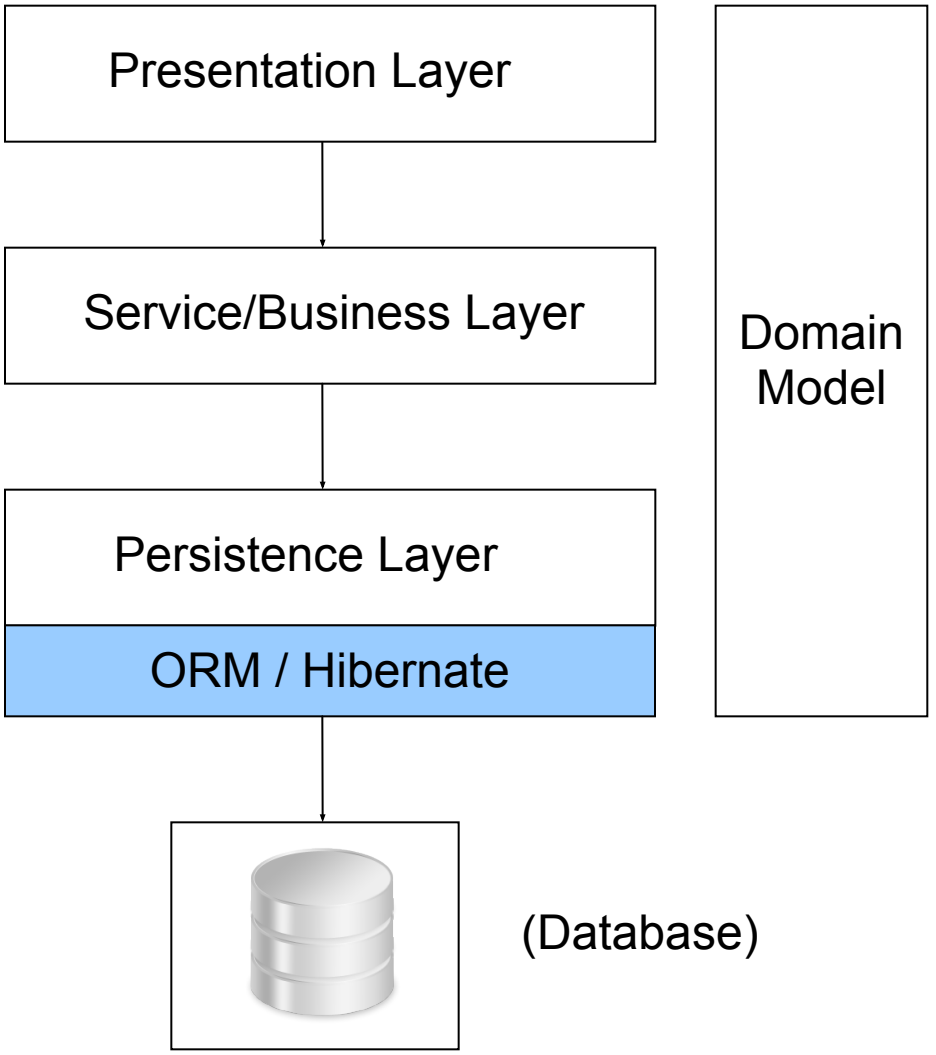
The preferred solution

- Use a *Object-Relational Mapping System* (eg. Hibernate)
- Provides a simple API for storing and retrieving Java objects directly to and from the database
- *Non-intrusive:* No need to follow specific rules or design patterns
- *Transparent*: Your object model is unaware

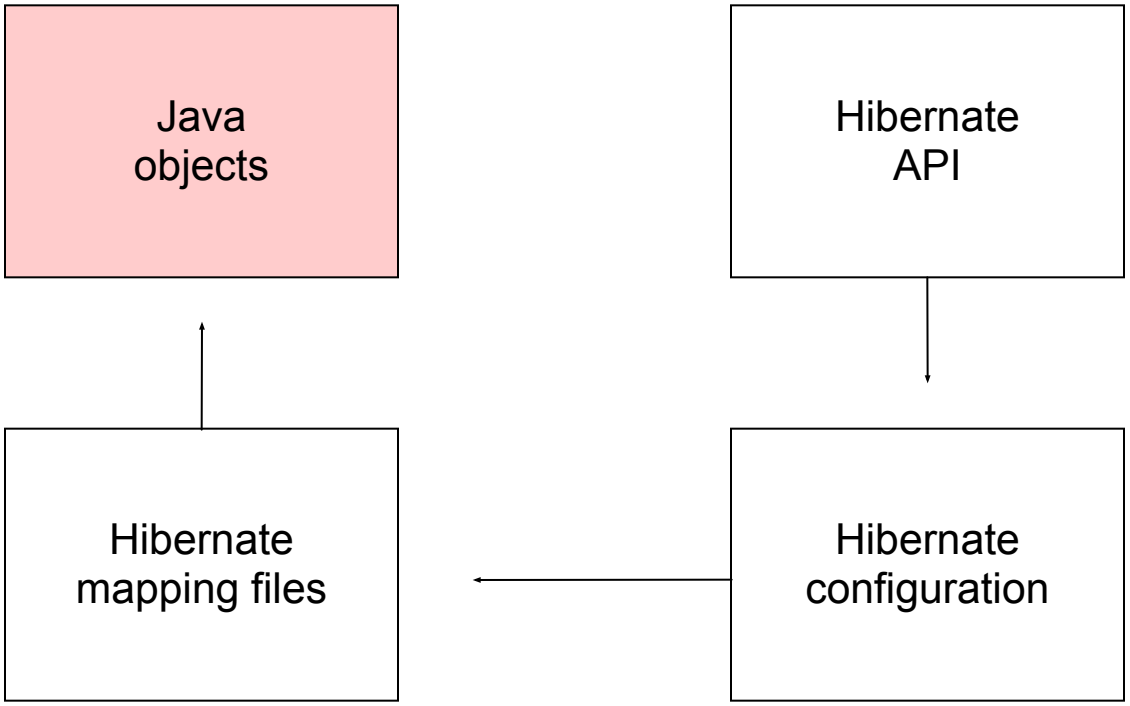


ORM and Architecture

- Middleware that manages persistence
- Provides an abstraction layer between the domain model and the database



Example app: The EventManager



Java objects (POJO)

Identifier property
(optional)

No-argument constructor
(required)

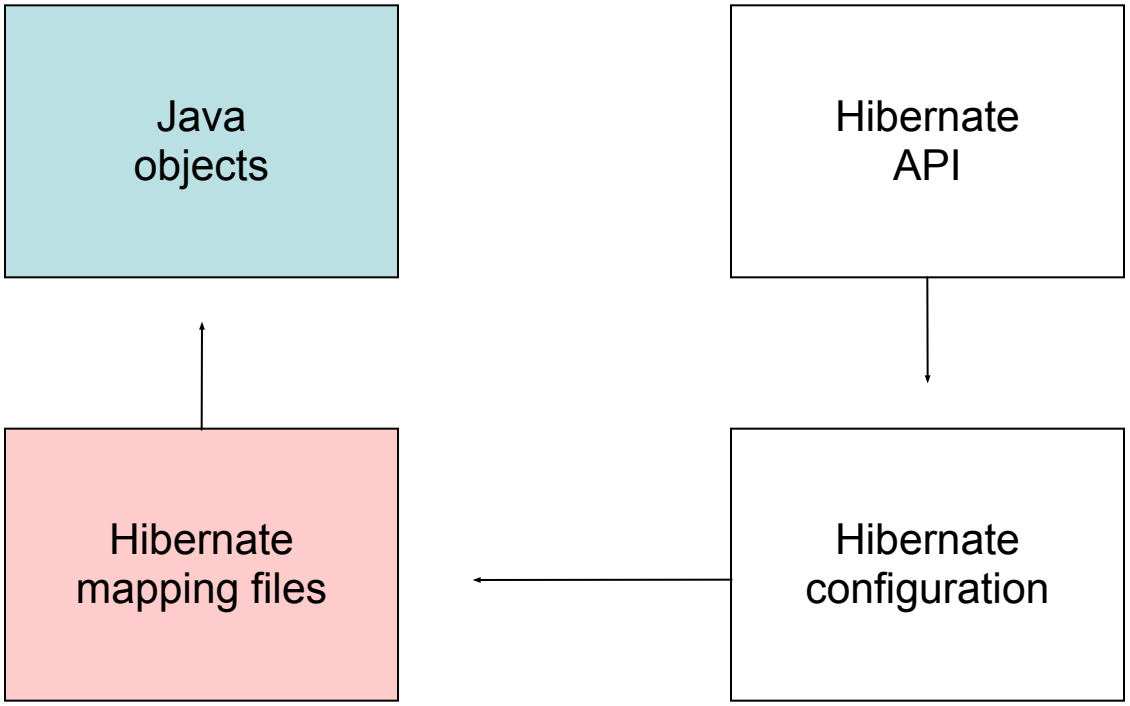
Declare accessors and mutators for persistent fields (optional)

- Properties need *not* be declared public - Hibernate can persist a property with a default, protected or private get / set pair.

Prefer non-final classes
(optional)

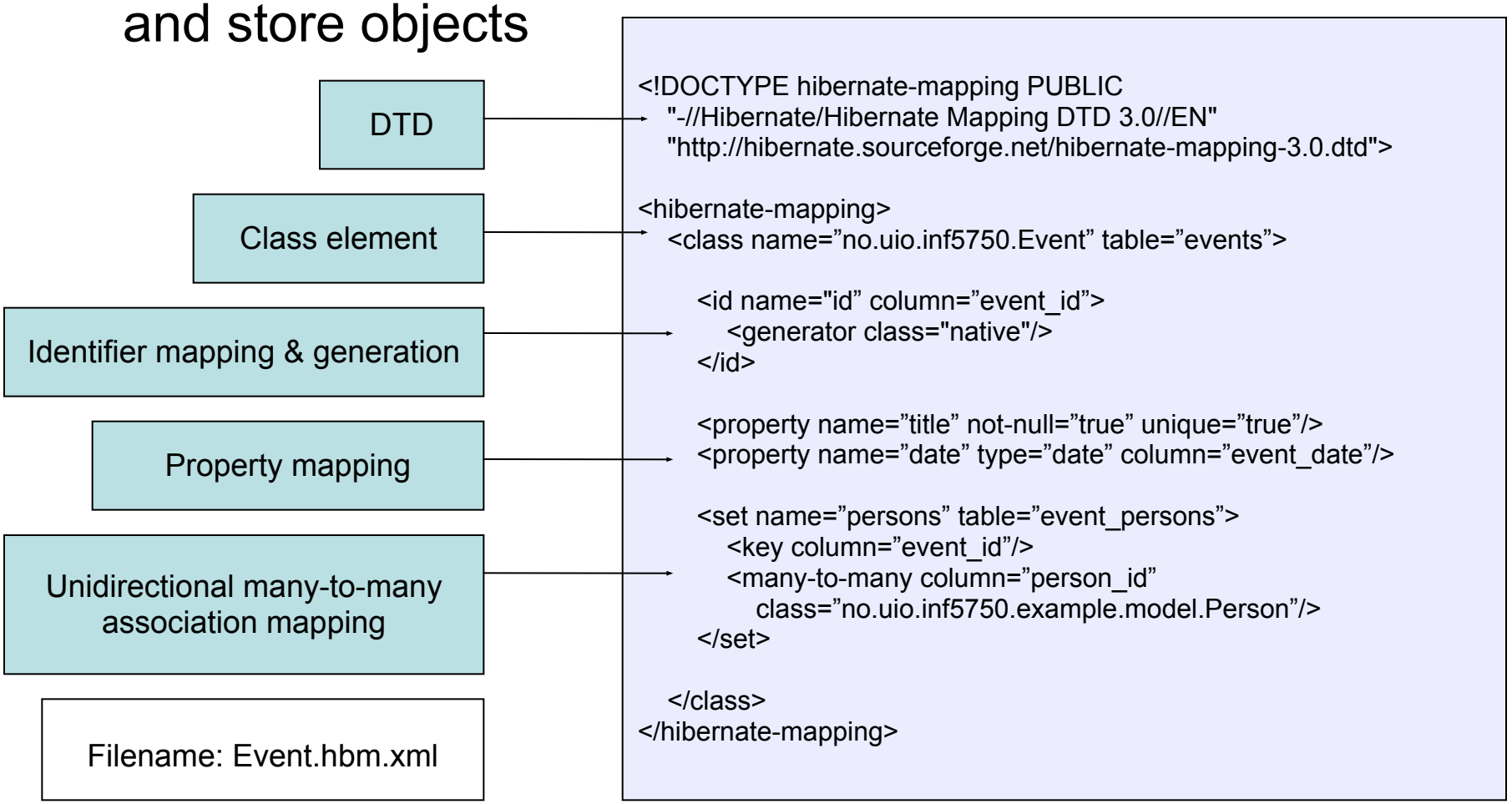
```
public class Event
{
    private int id;
    private String title;
    private Date date;
    private Set<Person> persons = new HashSet<Person>();

    public Event() {
     }

    public int getId() {
        return id;
    }

    private void setId( int id ) {
        this.id = id;
    }

    public String getTitle() {
        return title;
    }

    public void setTitle( String title ) {
        this.title = title;
    }

    // Getter and setter for date and persons
}
```

Example app: The EventManager

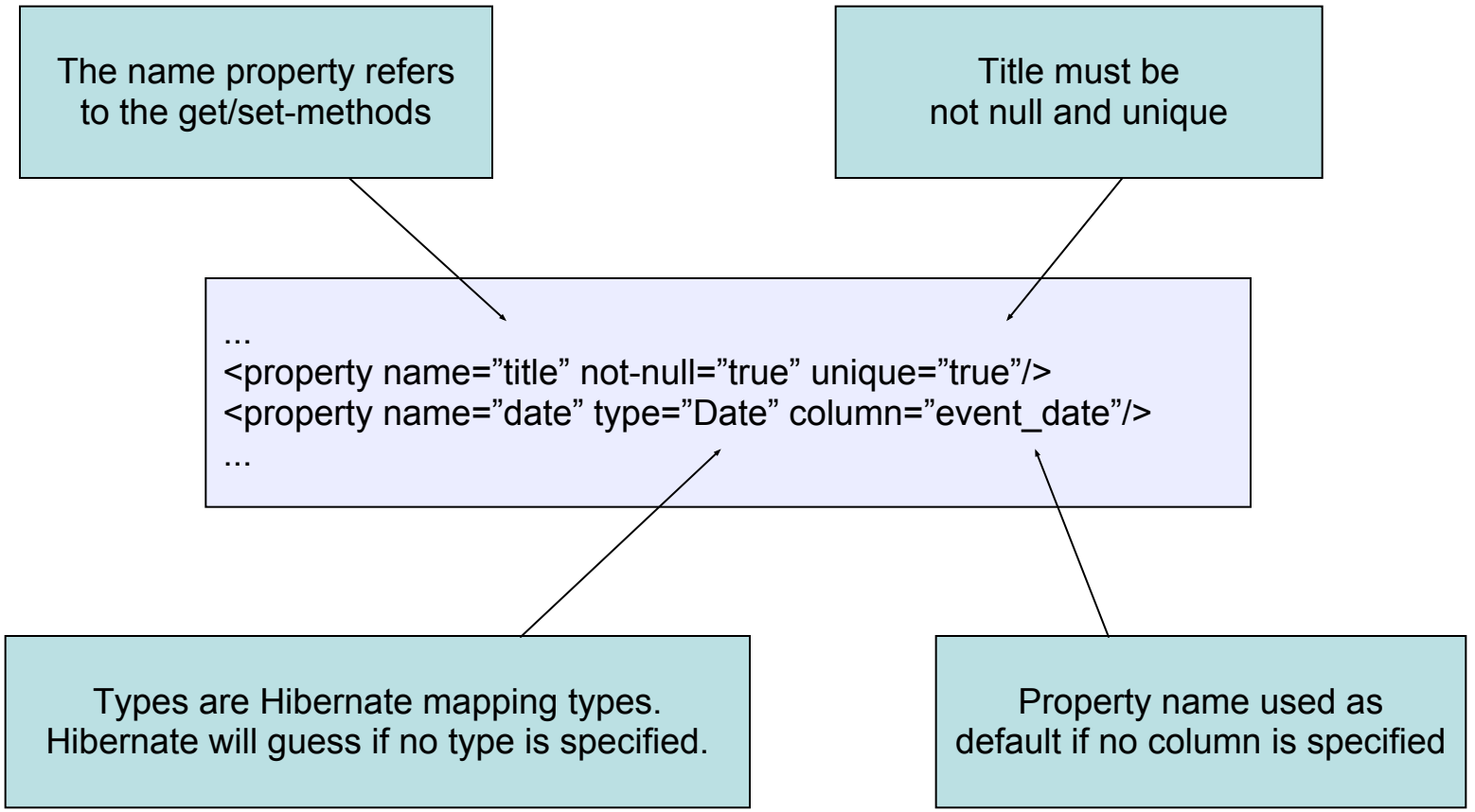


Hibernate mapping files

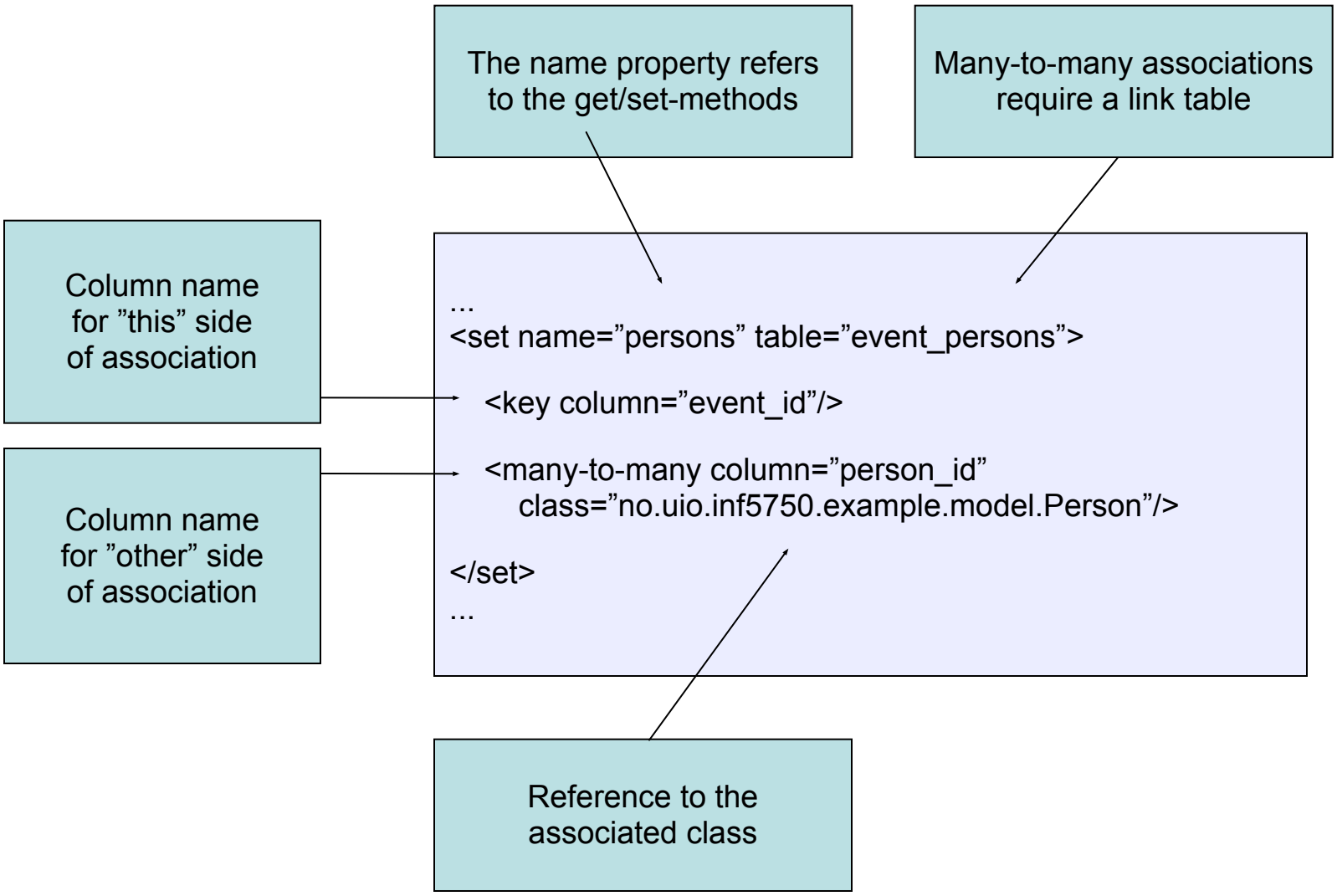
- Tells Hibernate which tables and columns to use to load and store objects



Property mapping



Association mapping

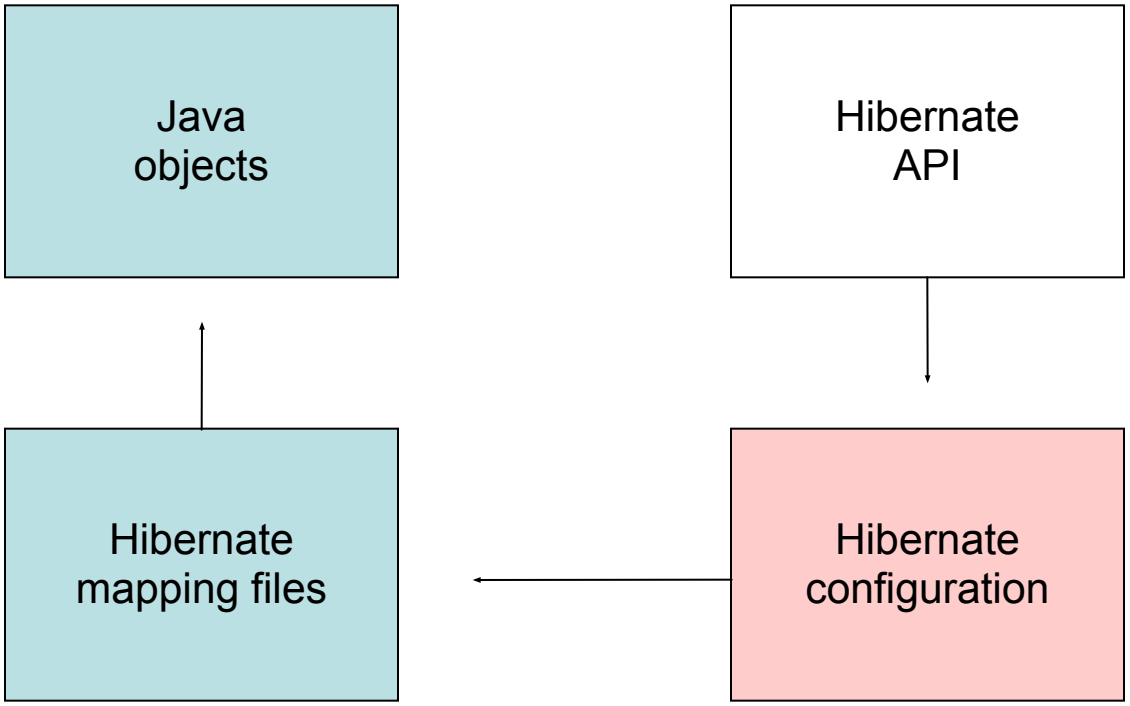


Hibernate mapping types

- Hibernate will translate Java types to SQL / database types for the properties of your mapped classes

Java type	**Hibernate type**	**SQL type**
java.lang.String	string	VARCHAR
java.util.Date	date, time	DATE, TIME
java.lang.Integer, int	integer	INT
java.lang.Class	class	varchar
java.io.Serializable	serializable	BLOB, BINARY

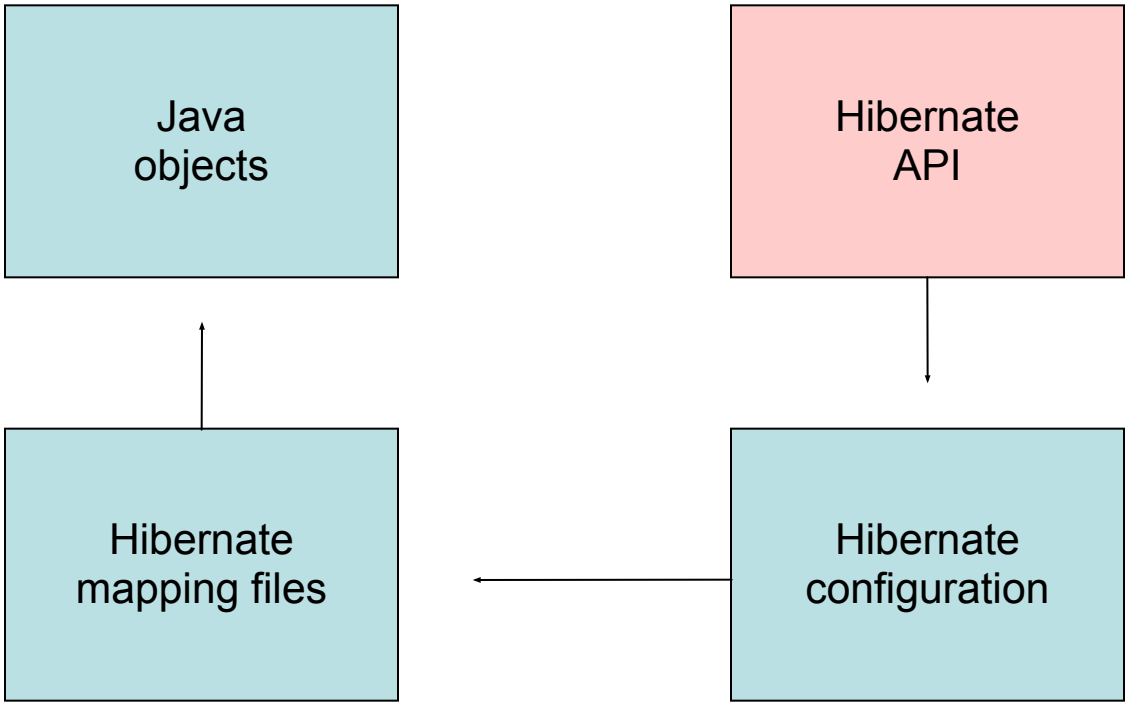
Example app: The EventManager



Hibernate configuration

- Also referred to hibernate properties
- Each database has a *dialect*
  - hibernate.dialect = org.hibernate.dialect.H2Dialect
- Must also specify:
  - JDBC driver class
  - Connection URL
  - Username
  - Password
- More later in the lecture...

Example app: The EventManager



The SessionFactory interface

- When all mappings have been parsed by the *org.hibernate.cfg.Configuration*, the application must obtain a factory to get *org.hibernate.Session*
- SessionFactory provides *org.hibernate.Session* instances to the application
- Shared among application threads
- Most important method is *getCurrentSession*

```
SessionFactory sessionFactory = cfg.buildSessionFactory();
```

OR let *Spring* inject it for you

```
<bean id="sessionFactory" class="org.springframework.orm.hibernate3.LocalSessionFactoryBean">
    <property name="dataSource" ref="dataSource"/>
     <property name="mappingResources">
    ….
</bean
```

The Session interface

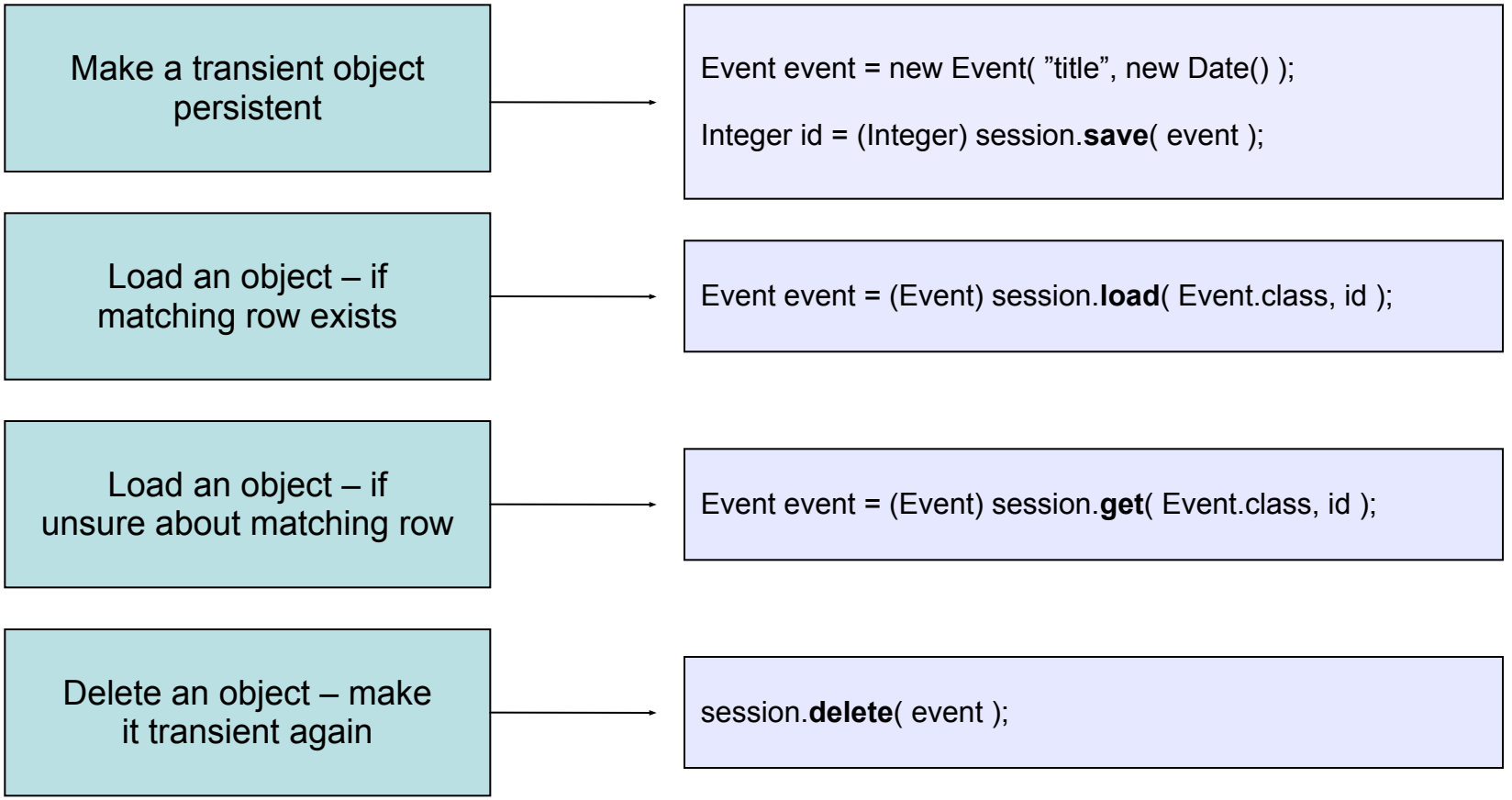
- Obtained from a SessionFactory
- Main runtime interface between a Java application and Hibernate
- Responsible for storing and retrieving objects
- Think of it as a collection of loaded objects related to a *single unit of work*

```
Session session =  sessionFactory.getCurrentSession();
```

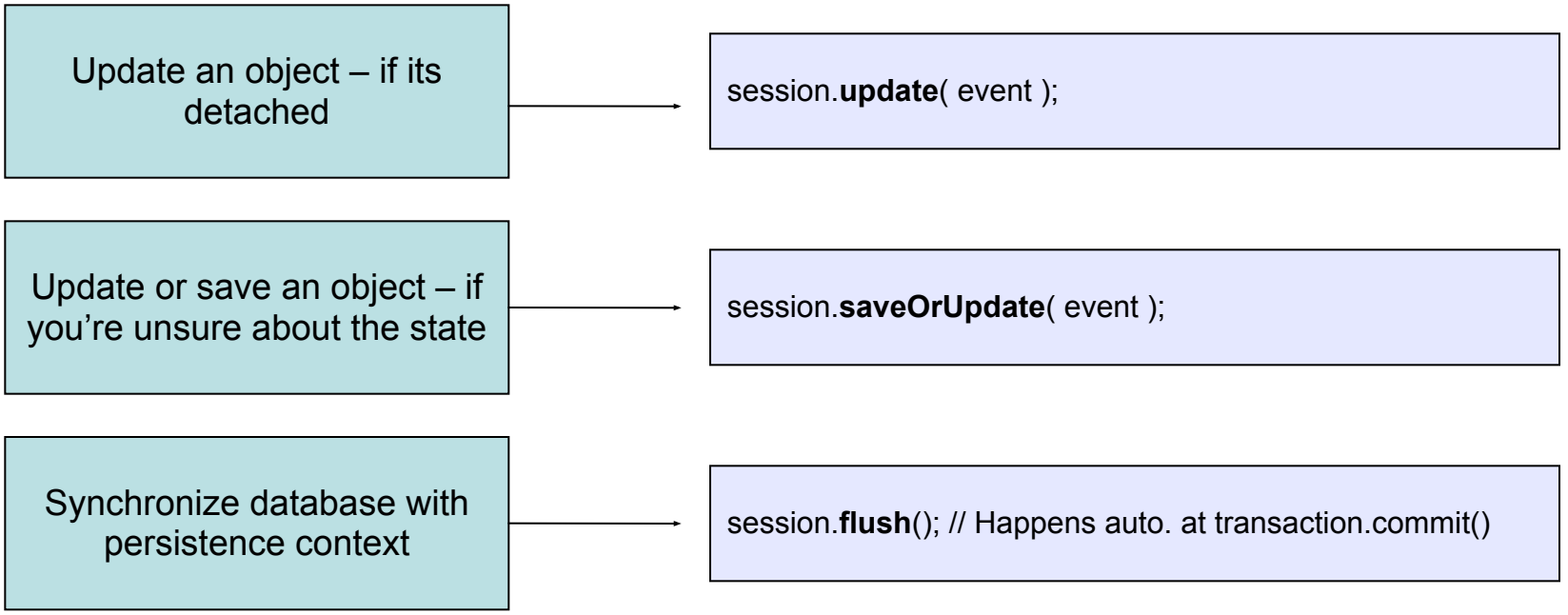
Instance states

- An object instance state is related to the *persistence context*
- The persistence context = a *Hibernate Session* instance
- Three types of instance states:
  - Transient
    - The instance is *not* associated with any persistence context
  - Persistent
    - The instance is associated with a persistence context
  - Detached
    - The instance was associated with a persistence context which has been closed – currently *not* associated

The Session interface



The Session interface



The Criteria interface

- You need a *query* when you don't know the identifiers of the objects you are looking for
- Criteria used for *programmatic* query creation

Retrieve all instances of Event

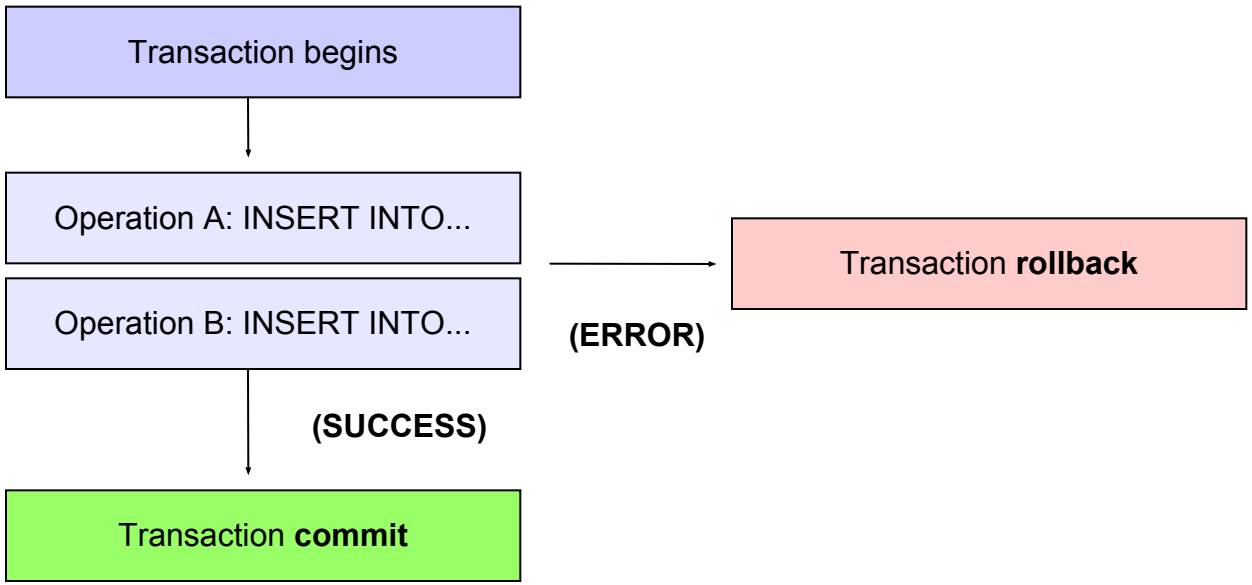
```
Criteria criteria = session.createCriteria( Event.class );

List events = criteria.list();
```

Narrow the result set

```
Criteria criteria = session.createCriteria( Event.class );

criteria.add( Restrictions.eq( "title", "Rolling Stones" ) );;
criteria.add( Restrictions.gt( "date", new Date() ) );

criteria.setMaxResults( 10 );

List events = criteria.list();
```

Transactions

- Transaction: A set of database operations which must be executed in entirety or not at all
- Should end either with a *commit* or a *rollback*
- All communication with a database has to occur inside a transaction!



Hibernate in real-life apps

- Spring used for SessionFactory management
  - Spring has excellent ORM integration
  - Custom SessionFactory management is “boilerplate-code”
- Spring used for Transaction management
  - Custom tx management is error prone
  - Support for declarative tx management with annotations
  - Consistent programming model across JTA, JDBC, Hibernate
- Annotate transactional methods / class with *@Transactional*
- Hibernate’s own connection pooling is basic. Hibernate allows external JDBC pooling through library called C3P0

Spring-Hibernate dependencies

```
...
<dependency>
  <groupId>org.springframework</groupId>
  <artifactId>spring-core</artifactId>
  <version>${spring.version}</version>
</dependency>
<dependency>
  <groupId>org.springframework</groupId>
  <artifactId>spring-context</artifactId>
  <version>${spring.version}</version>
</dependency>
<dependency>
  <groupId>org.springframework</groupId>
  <artifactId>spring-tx</artifactId>
  <version>${spring.version}</version>
</dependency>
<dependency>
  <groupId>org.springframework</groupId>
  <artifactId>spring-orm</artifactId>
  <version>${spring.version}</version>
</dependency>
```

```
...
<dependency>
  <groupId>org.hibernate</groupId>
  <artifactId>hibernate-core</artifactId>
  <version>${hibernate.version}</version>
</dependency>
<dependency>
  <groupId>org.hibernate</groupId>
  <artifactId>hibernate-entitymanager</artifactId>
  <version>3.5.1-Final</version>
</dependency>
<dependency>
  <groupId>geronimo-spec</groupId>
  <artifactId>geronimo-spec-jta</artifactId>
  <version>1.0-M1</version>
</dependency>
<dependency>
  <groupId>c3p0</groupId>
  <artifactId>c3p0</artifactId>
  <version>0.9.1.2</version>
</dependency>
<dependency>
  <groupId>org.slf4j</groupId>
  <artifactId>slf4j-log4j12</artifactId>
  <version>1.5.8</version>
</dependency>
<dependency>
  <groupId>com.h2database</groupId>
  <artifactId>h2</artifactId>
  <version>1.2.136</version>
</dependency>
```

Spring-Hibernate configuration

```
<tx:annotation-driven transaction-manager="transactionManager"/>

<bean id="transactionManager" class="org.springframework.orm.hibernate3.HibernateTransactionManager">
  <property name="sessionFactory" ref="sessionFactory"/>
  <property name="dataSource" ref="dataSource"/>
</bean>


<bean id="sessionFactory" class="org.springframework.orm.hibernate3.LocalSessionFactoryBean">
  <property name="dataSource" ref="dataSource"/>
  <property name="mappingResources">
    <list>
      <value>hibernate/Event.hbm.xml</value>
      <value>hibernate/Person.hbm.xml</value>
    </list>
  </property>
  <property name="hibernateProperties">
    <props>
      <prop key="hibernate.dialect">org.hibernate.dialect.H2Dialect</prop>
      <prop key="hibernate.hbm2ddl.auto">create-drop</prop>
    </props>
  </property>
</bean>


<bean id="dataSource" class="com.mchange.v2.c3p0.ComboPooledDataSource" destroy-method="close">
  <property name="driverClass" value="org.h2.Driver"/>
  <property name="jdbcUrl" value="jdbc:h2:mem:eventmanager;DB_CLOSE_ON_EXIT=FALSE"/>
  <property name="user" value="sa"/>
  <property name="password" value=""/>
</bean>
```

Enables annotations

Can be injected like any bean

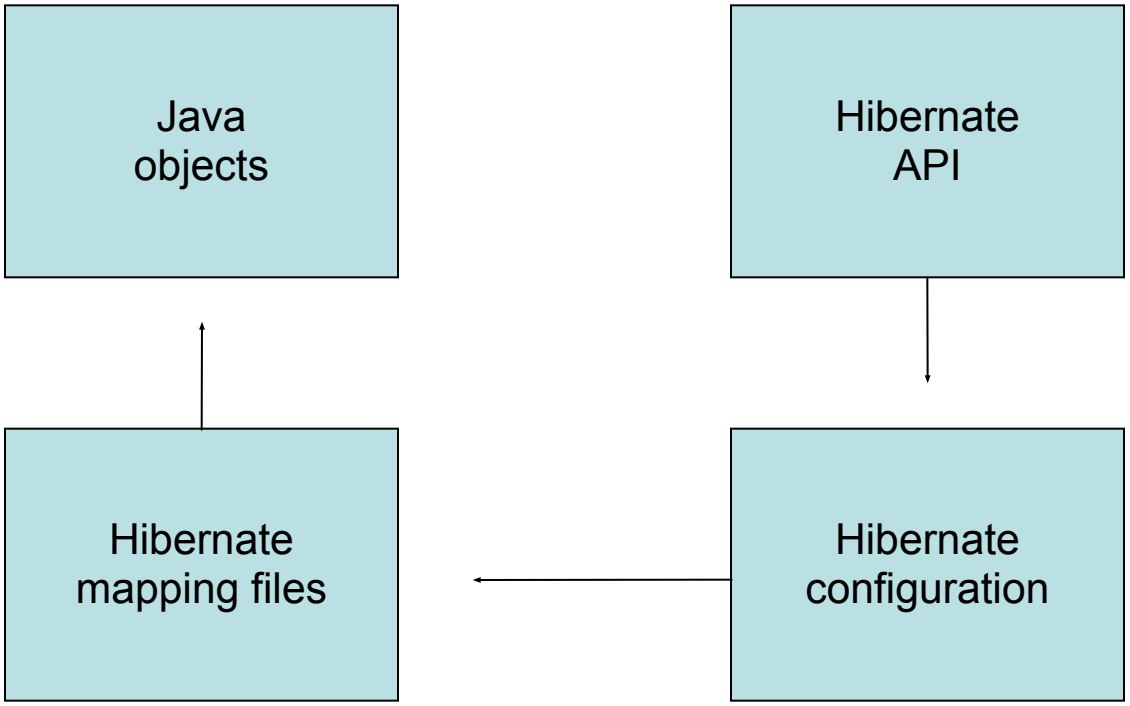
Points to mapping files

Hibernate properties

- H2 database (fast inmemory DB)
- Automatically create tables

Connection properties

Example: The EventManager



Advantages of ORM

- Productivity
  - Eliminates lots of repetitive code – focus on business logic
  - Database schema is generated automatically
- Maintainability
  - Fewer lines of code – easier to understand
  - Easier to manage change in the object model
- Database vendor independence
  - The underlying database is abstracted away
  - Can be configured outside the application
- Performance
  - Lazy loading – associations are fetched when needed
  - Caching

Resources

- Spring documentation chapter 13

http://static.springsource.org/spring/docs/3.2.x/spring-framework-reference/html/orm.html

- Hibernate reference documentation
  - www.hibernate.org -> Documentation -> Reference