JPA / Hibernate
Advanced Mappings

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Basic Mapping

Java Class

Database Table

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Advanced Mappings

- In the database, you most likely will have
  - Multiple Tables
  - Relationships between Tables
- Need to model this with Hibernate

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Advanced Mappings

- One-to-One
- One-to-Many, Many-to-One
- Many-to-Many

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One-to-One Mapping

- An instructor can have an "instructor detail" entity
  - Similar to an "instructor profile"

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One-to-Many Mapping

- An instructor can have many courses

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Many-to-Many Mapping

- A course can have many students
- A student can have many courses

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Important Database Concepts

- Primary key and foreign key

- Cascade

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Primary Key and Foreign Key

- Primary key: identify a unique row in a table

- Foreign key:
  - Link tables together
  - a field in one table that refers to primary key in another table

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Foreign Key Example

Foreign key column

Table: instructor

id	first_name	last_name	instructor_detail_id
1	Chad	Darby	100
2	Madhu	Patel	200

Table: instructor_detail

id	youtube_channel	hobby
100	www.luv2code.com/youtube	Luv 2 Code!!!
200	www.youtube.com	Guitar

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Cascade

- You can **cascade** operations

- Apply the same operation to related entities

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Cascade

- If we delete an **instructor**, we should also delete their **instructor_detail**
  - This is known as "CASCADE DELETE"

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Cascade Delete

Foreign key column

Table: instructor

id	first_name	last_name	instructor_detail_id
~~1~~	~~Chad~~	~~Darby~~	~~100~~
2	Madhu	Patel	200

Table: instructor_detail

id	youtube_channel	hobby
~~100~~	~~www.luv2code.com/youtube~~	~~Luv 2 Code!!!~~
200	www.youtube.com	Guitar

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Cascade Delete

- Cascade delete depends on the use case
- Should we do cascade delete here???

No way!!!

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Cascade Delete

- Cascade delete depends on the use case
- Should we do cascade delete here???

Developer can configure cascading

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Fetch Types: Eager vs Lazy Loading

- When we fetch / retrieve data, should we retrieve EVERYTHING?
  - **Eager** will retrieve everything
  - **Lazy** will retrieve on request

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Uni-Directional

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Bi-Directional

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JPA / Hibernate
One-to-One

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One-to-One Mapping

- An instructor can have an "instructor detail" entity
  - Similar to an "instructor profile"

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Uni-Directional

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Development Process: One-to-One

1. Prep Work - Define database tables
2. Create InstructorDetail class
3. Create Instructor class
4. Create Main App

Step-By-Step

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table: instructor_detail

File: create-db.sql

```
CREATE TABLE `instructor_detail` (

  `id`              int(11)      NOT NULL AUTO_INCREMENT,
  `youtube_channel` varchar(128) DEFAULT NULL,
  `hobby`           varchar(45)  DEFAULT NULL,


);

...
```

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table: instructor_detail

File: create-db.sql

```
CREATE TABLE `instructor_detail` (

  `id`              int(11)      NOT NULL AUTO_INCREMENT,
  `youtube_channel` varchar(128) DEFAULT NULL,
  `hobby`           varchar(45)  DEFAULT NULL,

  PRIMARY KEY (`id`)
);

...
```

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table: instructor

File: create-db.sql

```
...

CREATE TABLE `instructor` (

  `id`          int(11) NOT NULL AUTO_INCREMENT,
  `first_name`  varchar(45) DEFAULT NULL,
  `last_name`   varchar(45) DEFAULT NULL,
  `email`       varchar(45) DEFAULT NULL,
  `instructor_detail_id` int(11) DEFAULT NULL,

  PRIMARY KEY (`id`)
    ...
);
```

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Foreign Key

- Link tables together
- A field in one table that refers to primary key in another table

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Foreign Key Example

Foreign key column

Table: instructor

id	first_name	last_name	instructor_detail_id
1	Chad	Darby	100
2	Madhu	Patel	200

Table: instructor_detail

id	youtube_channel	hobby
100	www.luv2code.com/youtube	Luv 2 Code!!!
200	www.youtube.com	Guitar

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Defining Foreign Key

File: create-db.sql

```
...
CREATE TABLE `instructor` (
   ...

   CONSTRAINT `FK_DETAIL` FOREIGN KEY (`instructor_detail_id`)
   REFERENCES `instructor_detail` (`id`)

);
```

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More on Foreign Key

- Main purpose is to preserve relationship between tables
  - Referential Integrity
- Prevents operations that would destroy relationship
- Ensures only valid data is inserted into the foreign key column
  - Can only contain valid reference to primary key in other table

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Development Process: One-to-One

Step-By-Step

1. Prep Work - Define database tables
2. Create InstructorDetail class
3. Create Instructor class
4. Create Main App

Step 2: Create InstructorDetail class

```
@Entity
@Table(name="instructor_detail")
public class InstructorDetail {

}
```

Step 2: Create InstructorDetail class

```
@Entity
@Table(name="instructor_detail")
public class InstructorDetail {

    @Id
    @GeneratedValue(strategy=GenerationType.IDENTITY)
    @Column(name="id")
    private int id;



}
```

Step 2: Create InstructorDetail class

```
@Entity
@Table(name="instructor_detail")
public class InstructorDetail {

    @Id
    @GeneratedValue(strategy=GenerationType.IDENTITY)
    @Column(name="id")
    private int id;

    @Column(name="youtube_channel")
    private String youtubeChannel;



}
```

Step 2: Create InstructorDetail class

```
@Entity
@Table(name="instructor_detail")
public class InstructorDetail {

    @Id
    @GeneratedValue(strategy=GenerationType.IDENTITY)
    @Column(name="id")
    private int id;

    @Column(name="youtube_channel")
    private String youtubeChannel;

    @Column(name="hobby")
    private String hobby;



}
```

Step 2: Create InstructorDetail class

```
@Entity
@Table(name="instructor_detail")
public class InstructorDetail {

    @Id
    @GeneratedValue(strategy=GenerationType.IDENTITY)
    @Column(name="id")
    private int id;

    @Column(name="youtube_channel")
    private String youtubeChannel;

    @Column(name="hobby")
    private String hobby;

    // constructors

    // getters / setters
}
```

Step 3: Create Instructor class

```
@Entity
@Table(name="instructor")
public class Instructor {

    @Id
    @GeneratedValue(strategy=GenerationType.IDENTITY)
    @Column(name="id")
    private int id;

    @Column(name="first_name")
    private String firstName;

    @Column(name="last_name")
    private String lastName;

    @Column(name="email")
    private String email;

    ...
    // constructors, getters / setters
}
```

Step 3: Create Instructor class - @OneToOne

```
@Entity
@Table(name="instructor")
public class Instructor {
    ...

    @OneToOne
    @JoinColumn(name="instructor_detail_id")
    private InstructorDetail instructorDetail;

    ...
    // constructors, getters / setters
}
```

Entity Lifecycle

Operations	Description
Detach	If entity is detached, it is not associated with a Hibernate session
Merge	If instance is detached from session, then merge will reattach to session
Persist	Transitions new instances to managed state. Next flush / commit will save in db.
Remove	Transitions managed entity to be removed. Next flush / commit will delete from db.
Refresh	Reload / synch object with data from db. Prevents stale data

Entity Lifecycle - session method calls

Cascade

- Recall: You can **cascade** operations

- Apply the same operation to related entities

Cascade Delete

Foreign key column

Table: instructor

id	first_name	last_name	instructor_detail_id
~~1~~	~~Chad~~	~~Darby~~	~~100~~
2	Madhu	Patel	200

Table: instructor_detail

id	youtube_channel	hobby
~~100~~	~~www.luv2code.com/youtube~~	~~Luv 2 Code!!!~~
200	www.youtube.com	Guitar

@OneToOne - Cascade Types

Cascade Type	Description
PERSIST	If entity is persisted / saved, related entity will also be persisted
REMOVE	If entity is removed / deleted, related entity will also be deleted
REFRESH	If entity is refreshed, related entity will also be refreshed
DETACH	If entity is detached (not associated w/ session), then related entity will also be detached
MERGE	If entity is merged, then related entity will also be merged
ALL	All of above cascade types

Configure Cascade Type

```
@Entity
@Table(name="instructor")
public class Instructor {
   ...

   @OneToOne(cascade=CascadeType.ALL)
   @JoinColumn(name="instructor_detail_id")
   private InstructorDetail instructorDetail;


   ...
   // constructors, getters / setters
}
```

By default, no operations are cascaded.

Configure Multiple Cascade Types

```
@OneToOne(cascade={CascadeType.DETACH,
                   CascadeType.MERGE,
                   CascadeType.PERSIST,
                   CascadeType.REFRESH,
                   CascadeType.REMOVE})
```

Step 4 - Creating Spring Boot - Command Line App

- We will create a Spring Boot - Command Line App
- This will allow us to focus on JPA / Hibernate
- Leverage our DAO pattern as in previous videos

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Define DAO interface

```
import com.luv2code.cruddemo.entity.Instructor;

public interface AppDAO {

    void save(Instructor theInstructor);

}
```

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Define DAO implementation

```
import com.luv2code.cruddemo.entity.Instructor;
import jakarta.persistence.EntityManager;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Repository;
import org.springframework.transaction.annotation.Transactional;

@Repository
public class AppDAOImpl implements AppDAO {

    // define field for entity manager
    private EntityManager entityManager;

    // inject entity manager using constructor injection
    @Autowired
    public AppDAOImpl(EntityManager entityManager) {
        this.entityManager = entityManager;
    }

    @Override
    @Transactional
    public void save(Instructor theInstructor) {
        entityManager.persist(theInstructor);
    }

}
```

Inject the Entity Manager

Save the Java object

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Define DAO implementation

```
import com.luv2code.cruddemo.entity.Instructor;
import jakarta.persistence.EntityManager;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Repository;
import org.springframework.transaction.annotation.Transactional;

@Repository
public class AppDAOImpl implements AppDAO {

    // define field for entity manager
    private EntityManager entityManager;

    // inject entity manager using constructor injection
    @Autowired
    public AppDAOImpl(EntityManager entityManager) {
        this.entityManager = entityManager;
    }

    @Override
    @Transactional
    public void save(Instructor theInstructor) {
        entityManager.persist(theInstructor);
    }

}
```

This will ALSO save the details object

Because of CascadeType.ALL

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Update main app

```java
@SpringBootApplication
public class MainApplication {

    public static void main(String[] args) {
        SpringApplication.run(MainApplication.class, args);
    }

    @Bean
    public CommandLineRunner commandLineRunner(AppDAO appDAO) {
        return runner -> {

            createInstructor(appDAO);
    }

    …
```

Inject the AppDAO

```java
    private void createInstructor(AppDAO appDAO) {

        // create the instructor
        Instructor tempInstructor =
                new Instructor("Chad", "Darby", "darby@luv2code.com");

        // create the instructor detail
        InstructorDetail tempInstructorDetail =
                new InstructorDetail(
                        "http://www.luv2code.com/youtube",
                        "Luv 2 code!!!");

        // associate the objects
        tempInstructor.setInstructorDetail(tempInstructorDetail);

        // save the instructor
        System.out.println("Saving instructor: " + tempInstructor);
        appDAO.save(tempInstructor);

        System.out.println("Done!");
    }
}
```

Remember:

This will ALSO save the details object

Because of CascadeType.ALL

In AppDAO, delegated to entityManager.persist(…)

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JPA / Hibernate
One-to-One: Find an entity

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Define DAO implementation

```
@Repository
public class AppDAOImpl implements AppDAO {

   …

   @Override
   public Instructor findInstructorById(int theId) {
       return entityManager.find(Instructor.class, theId);
   }

}
```

We'll add supporting code in the video: interface, main app

This will ALSO retrieve the instructor details object

Because of default behavior of @OneToOne fetch type is eager … more on fetch types later

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JPA / Hibernate
One-to-One: Delete an entity

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Define DAO implementation

```
@Repository
public class AppDAOImpl implements AppDAO {
    …

   @Override
   @Transactional
   public void deleteInstructorById(int theId) {

       // retrieve the instructor
       Instructor tempInstructor = entityManager.find(Instructor.class, theId);

       // delete the instructor
       entityManager.remove(tempInstructor);
   }

}
```

We'll add supporting code in the video: interface, main app

This will ALSO delete the instructor details object

Because of CascadeType.ALL

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JPA / Hibernate
One-to-One: Bi-Directional

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One-to-One Mapping

- We currently have a uni-directional mapping

New Use Case

- If we load an InstructorDetail
  - Then we'd like to get the associated Instructor

- Can't do this with current uni-directional relationship :-(

Bi-Directional

- Bi-Directional relationship is the solution

- We can start with InstructorDetail and make it back to the Instructor

Bi-Directional - The Good News

- To use Bi-Directional, we can keep the existing database schema
  - No changes required to database
- Simply update the Java code

Development Process: One-to-One (Bi-Directional)

Step-By-Step

1. Make updates to InstructorDetail class:
    1. Add new field to reference Instructor
    2. Add getter/setter methods for Instructor
    3. Add @OneToOne annotation

2. Create Main App

Step 1.1: Add new field to reference Instructor

```
@Entity
@Table(name="instructor_detail")
public class InstructorDetail {
    ...

    private Instructor instructor;

    ...
}
```

Step 1.2: Add getter/setter methods Instructor

```
@Entity
@Table(name="instructor_detail")
public class InstructorDetail {
    ...


    private Instructor instructor;

    public Instructor getInstructor() {
        return instructor;
    }

    public void setInstructor(Instructor instructor) {
        this.instructor = instructor;
    }
    ...

}
```

Step 1.3: Add @OneToOne annotation

```
@Entity
@Table(name="instructor_detail")
public class InstructorDetail {
   ...

   @OneToOne(mappedBy="instructorDetail")
   private Instructor instructor;

   public Instructor getInstructor() {
      return instructor;
   }

   public void setInstructor(Instructor instructor) {
      this.instructor = instructor;
   }
   ...

}
```

Refers to “instructorDetail” property in “Instructor” class

More on mappedBy

```
public class InstructorDetail {
    ...

    @OneToOne(mappedBy="instructorDetail")
    private Instructor instructor;
```

- **mappedBy** tells Hibernate
  - Look at the instructorDetail property in the Instructor class
  - Use information from the Instructor class @JoinColumn
  - To help find associated instructor

```
public class Instructor {
    ...

    @OneToOne(cascade=CascadeType.ALL)
    @JoinColumn(name="instructor_detail_id")
    private InstructorDetail instructorDetail;
```

Add support for Cascading

Cascade all operations
to the associated Instructor

```
@Entity
@Table(name="instructor_detail")
public class InstructorDetail {
   ...

   @OneToOne(mappedBy="instructorDetail", cascade=CascadeType.ALL)
   private Instructor instructor;

   public Instructor getInstructor() {
      return instructor;
   }

   public void setInstructor(Instructor instructor) {
      this.instructor = instructor;
   }
   ...

}
```

Define DAO interface

```
import com.luv2code.cruddemo.entity.Instructor;

public interface AppDAO {

    InstructorDetail findInstructorDetailById(int theId);

}
```

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Define DAO implementation

```
import com.luv2code.cruddemo.entity.InstructorDetail;
…

@Repository
public class AppDAOImpl implements AppDAO {

    // define field for entity manager
    private EntityManager entityManager;

    // inject entity manager using constructo
   …

    @Override
    public InstructorDetail findInstructorDetailById(int theId) {

        return entityManager.find(InstructorDetail.class, theId);
    }

}
```

This will ALSO retrieve the instructor object

Because of default behavior of @OneToOne

Retrieve the InstructorDetail

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Update main app

```java
@SpringBootApplication
public class MainApplication {

    public static void main(String[] args) {
        SpringApplication.run(MainApplication.class, args);
    }

    @Bean
    public CommandLineRunner commandLineRunner(AppDAO appDAO) {
        return runner -> {

            findInstructorDetail(appDAO);
    }

    …
```

Inject the AppDAO

```java
    private void findInstructorDetail(AppDAO appDAO) {

        int theId = 1;
        System.out.println("Finding instructor detail id: " + theId);

        InstructorDetail tempInstructorDetail = appDAO.findInstructorDetailById(theId);

        System.out.println("tempInstructorDetail: " + tempInstructorDetail);
        System.out.println("the associated instructor: " + tempInstructorDetail.getInstructor());

    }
}
```


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JPA / Hibernate
One-to-Many

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One-to-Many Mapping

- An instructor can have many courses
  - Bi-directional

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Many-to-One Mapping

- Many courses can have one instructor
  - Inverse / opposite of One-to-Many

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Real-World Project Requirement

- If you delete an instructor, DO NOT delete the courses
- If you delete a course, DO NOT delete the instructor

Do not apply cascading deletes!

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Development Process: One-to-Many

1. Prep Work - Define database tables
2. Create Course class
3. Update Instructor class
4. Create Main App

Step-By-Step

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table: course

File: create-db.sql

```
CREATE TABLE `course` (

  `id` int(11) NOT NULL AUTO_INCREMENT,
  `title` varchar(128) DEFAULT NULL,
  `instructor_id` int(11) DEFAULT NULL,

  PRIMARY KEY (`id`),

  UNIQUE KEY `TITLE_UNIQUE` (`title`),
   ...
);
```

Prevent duplicate course titles

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table: course - foreign key

File: create-db.sql

```
CREATE TABLE `course` (
  …
   KEY `FK_INSTRUCTOR_idx` (`instructor_id`),
   CONSTRAINT `FK_INSTRUCTOR`
   FOREIGN KEY (`instructor_id`)
   REFERENCES `instructor` (`id`)
   …
);
```

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table: instructor - no changes

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Step 2: Create Course class

```
@Entity
@Table(name="course")
public class Course {

    @Id
    @GeneratedValue(strategy=GenerationType.IDENTITY)
    @Column(name="id")
    private int id;

    @Column(name="title")
    private String title;

    ...
    // constructors, getters / setters
}
```

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Step 2: Create Course class - @ManyToOne

```
@Entity
@Table(name="course")
public class Course {
    …

    @ManyToOne
    @JoinColumn(name="instructor_id")
    private Instructor instructor;

    …
    // constructors, getters / setters
}
```

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Step 3: Update Instructor - reference courses

```
@Entity
@Table(name="instructor")
public class Instructor {
    ...

    private List<Course> courses;

    ...
}
```


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Step 3: Update Instructor - reference courses

```
@Entity
@Table(name="instructor")
public class Instructor {
    ...

    private List<Course> courses;

    public List<Course> getCourses() {
        return courses;
    }

    public void setCourses(List<Course> courses) {
        this.courses = courses;
    }
    ...

}
```


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Add @OneToMany annotation

```
@Entity
@Table(name="instructor")
public class Instructor {
   ...

   @OneToMany(mappedBy="instructor")
   private List<Course> courses;

   public List<Course> getCourses() {
      return courses;
   }

   public void setCourses(List<Course> courses) {
      this.courses = courses;
   }

   ...

}
```

Refers to “instructor” property in “Course” class

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More: mappedBy

```
public class Instructor {
    ...

    @OneToMany(mappedBy="instructor")
    private List<Course> courses;
```

- **mappedBy** tells Hibernate
  - Look at the instructor property in the Course class
  - Use information from the Course class @JoinColumn
  - To help find associated courses for instructor

```
public class Course {
    ...

    @ManyToOne
    @JoinColumn(name="instructor_id")
    private Instructor instructor;
```


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Add support for Cascading

```
@Entity
@Table(name="instructor")
public class Instructor {
   ...

   @OneToMany(mappedBy="instructor",
                  cascade={CascadeType.PERSIST, CascadeType.MERGE
                       CascadeType.DETACH, CascadeType.REFRESH})
   private List<Course> courses;



   ...

}
```

Do not apply cascading deletes!

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Add support for Cascading

```
@Entity
@Table(name="course")
public class Course {
   …

   @ManyToOne(cascade={CascadeType.PERSIST, CascadeType.MERGE
                       CascadeType.DETACH, CascadeType.REFRESH})
   @JoinColumn(name="instructor_id")
   private Instructor instructor;

   …
   // constructors, getters / setters
}
```

Do not apply cascading deletes!

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Add convenience methods for bi-directional

```
@Entity
@Table(name="instructor")
public class Instructor {
   ...
   // add convenience methods for bi-directional relationship

   public void add(Course tempCourse) {

      if (courses == null) {
         courses = new ArrayList<>();
      }

      courses.add(tempCourse);

      tempCourse.setInstructor(this);
   }
   ...
}
```

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Fetch Types: Eager vs Lazy

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Fetch Types: Eager vs Lazy Loading

- When we fetch / retrieve data, should we retrieve EVERYTHING?
  - **Eager** will retrieve everything
  - **Lazy** will retrieve on request

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Eager Loading

- Eager loading will load all dependent entities
  - Load instructor and all of their courses at once

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Eager Loading

- What about course and students?
  - Could easily turn into a performance nightmare …

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Eager Loading

- In our app, if we are searching for a course by keyword
  - Only want a list of matching courses

- Eager loading would still **load all students** for **each course** …. not good!

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Best Practice

Only load data when absolutely needed

Prefer Lazy loading
instead of
Eager loading

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Lazy Loading

- Lazy loading will load the main entity first
  - Load dependent entities on demand (lazy)

Lazy Loading is preferred

Load on demand (lazy)

Load course first

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Real-World Use Case

- Search for instructors

Last Name	First Name	Email	Action
Public	Mary	mary@luv2code.com	View Details
Doe	John	john@luv2code.com	View Details
Rao	Ajay	ajay@luv2code.com	View Details
Kublanov	Victor	victor@luv2code.com	View Details
O'Keefe	Paul	paul@luv2code.com	View Details
Peterson	Anthony	anthony@luv2code.com	View Details
Patel	Trupti	trupti@luv2code.com	View Details

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Real-World Use Case

- In Master view, use lazy loading

- In Detail view, retrieve the entity and necessary dependent entities

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Real-World Use Case - Master View

- In Master view, use lazy loading for search results
- Only load instructors … not their courses

result in an overall faster query for database

Last Name	First Name	Email	Action
Public	Mary	mary@luv2code.com	View Details
Doe	John	john@luv2code.com	View Details
Rao	Ajay	ajay@luv2code.com	View Details
Kublanov	Victor	victor@luv2code.com	View Details
O'Keefe	Paul	paul@luv2code.com	View Details
Peterson	Anthony	anthony@luv2code.com	View Details
Patel	Trupti	trupti@luv2code.com	View Details

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Real-World Use Case - Detail View

- In Detail view, retrieve the entity and necessary dependent entities
- Load instructor AND their courses

List of courses

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Fetch Type

- When you define the mapping relationship
  - You can specify the fetch type: EAGER or LAZY

```
@Entity
@Table(name="instructor")
public class Instructor {
   ...

   @OneToMany(fetch=FetchType.LAZY, mappedBy="instructor")
   private List<Course> courses;

   ...

}
```


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Default Fetch Types

Mapping	Default Fetch Type
@OneToOne	FetchType.EAGER
@OneToMany	FetchType.LAZY
@ManyToOne	FetchType.EAGER
@ManyToMany	FetchType.LAZY

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Overriding Default Fetch Type

- Specifying the fetch type, overrides the defaults

Mapping	Default Fetch Type
@ManyToOne	FetchType.EAGER

```
@ManyToOne(fetch=FetchType.LAZY)
@JoinColumn(name="instructor_id")
private Instructor instructor;
```


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More about Lazy Loading

- When you lazy load, the data is only retrieved on demand

- However, this requires an open Hibernate session
  - need an connection to database to retrieve data

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More about Lazy Loading

- If the Hibernate session is closed
  - And you attempt to retrieve lazy data
  - Hibernate will throw an exception

Watch out for this!

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Lazy: Find Courses

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Previous Solution: Eager

- **Eager** will retrieve everything … all of the courses for an instructor
- But we may not want this ALL of the time
- We'd like the option to load courses as needed …

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Fetch Type

- Change the fetch type back to LAZY

```
@Entity
@Table(name="instructor")
public class Instructor {
   ...

   @OneToMany(fetch=FetchType.LAZY, mappedBy="instructor")
   private List<Course> courses;

   ...

}
```

FetchType for @OneToMany defaults to lazy …
But I will explicitly list it for readability

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Add new method to find courses for instructor

File: AppDAOImpl.java

```
@Override
public List<Course> findCoursesByInstructorId(int theId) {

    // create query
    TypedQuery<Course> query = entityManager.createQuery("from Course where instructor.id = :data", Course.class);
    query.setParameter("data", theId);

    // execute query
    List<Course> courses = query.getResultList();

    return courses;
}
```

File: CruddemoApplication.java

```
private void findCoursesForInstructor(AppDAO appDAO) {

    int theId = 1;

    // find the instructor
    Instructor tempInstructor = appDAO.findInstructorById(theId);
    System.out.println("tempInstructor: " + tempInstructor);

    // find courses for instructor
    List<Course> courses = appDAO.findCoursesByInstructorId(theId);

    // associate the objects
    tempInstructor.setCourses(courses);

    System.out.println("the associated courses: " + tempInstructor.getCourses());
}
```

Since fetch type for courses is lazy

This will retrieve the instructor WITHOUT courses

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Lazy: Find Instructor with Courses

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Previous Solution: Find Courses for Instructor

- Previous solution was OK … but …
- Required an extra query
- I wish we could have a new method that would
  - Get instructor AND courses … in a single query
  - Also keep the LAZY option available … don't change fetch type

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Add new method to find instructor with courses

File: AppDAOImpl.java

```java
@Override
public Instructor findInstructorByIdJoinFetch(int theId) {

    // create query
    TypedQuery<Instructor> query = entityManager.createQuery(
                                        "select i from Instructor i "
                                                + "JOIN FETCH i.courses "
                                                + "where i.id = :data", Instructor.class);

    query.setParameter("data", theId);

    // execute query
    Instructor instructor = query.getSingleResult();

    return instructor;
}
```

Even with Instructor
@OneToMany(fetchType=LAZY)

This code will still retrieve Instructor AND Courses

The JOIN FETCH is similar to EAGER loading

File: CruddemoApplication.java

```java
private void findInstructorWithCoursesJoinFetch(AppDAO appDAO) {

   int theId = 1;

   // find the instructor
   System.out.println("Finding instructor id: " + theId);
   Instructor tempInstructor = appDAO.findInstructorByIdJoinFetch(theId);

   System.out.println("tempInstructor: " + tempInstructor);
   System.out.println("the associated courses: " + tempInstructor.getCourses());

   System.out.println("Done!");
}
```

This code will still retrieve Instructor AND Courses

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We have options now

- If you only need Instructor … and no courses, then call
  - appDAO.findInstructorById(…)
- If you need Instructor AND courses, then call
  - appDAO.findInstructorByIdJoinFetch(…)
- This gives us flexibility instead of having EAGER fetch hard-coded

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@OneToMany: Update Instructor

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Update Instructor

- Find an instructor by ID
- Change the instructor's data by calling setter method(s)
- Update the instructor using the DAO

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Add new DAO method to update instructor

File: AppDAOImpl.java

```
@Override
@Transactional
public void update(Instructor tempInstructor) {
    entityManager.merge(tempInstructor);
}
```

merge(…) will update an existing entity

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Main app

File: CruddemoApplication.java

```
private void updateInstructor(AppDAO appDAO) {

  int theId = 1;

  System.out.println("Finding instructor id: " + theId);
  Instructor tempInstructor = appDAO.findInstructorById(theId);

  System.out.println("Updating instructor id: " + theId);
  tempInstructor.setLastName("TESTER");

  appDAO.update(tempInstructor);

  System.out.println("Done");
}
```

Change instructor's data

Call DAO method
to update database

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@OneToMany: Update Course

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Update Course

- Find a course by ID
- Change the course's data by calling setter method(s)
- Update the course using the DAO

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Add new DAO method to update course

File: AppDAOImpl.java

```
@Override
@Transactional
public void update(Course tempCourse) {
    entityManager.merge(tempCourse);
}
```

merge(…) will update an existing entity

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Main app

File: CruddemoApplication.java

```
private void updateCourse(AppDAO appDAO) {

  int theId = 10;

  System.out.println("Finding course id: " + theId);
  Course tempCourse = appDAO.findCourseById(theId);

  System.out.println("Updating course id: " + theId);
  tempCourse.setTitle("Enjoy the Simple Things");

  appDAO.update(tempCourse);

  System.out.println("Done");
}
```

Change course's data

Call DAO method
to update database

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@OneToMany: Delete Instructor

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Delete instructor

- Find an instructor by ID
- Break association of all instructor's courses
- Delete the instructor

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Add new DAO method to delete instructor

File: AppDAOImpl.java

```
@Override
@Transactional
public void deleteInstructorById(int theId) {

    // retrieve the instructor
    Instructor tempInstructor = entityManager.find(Instructor.class, theId);

    List<Course> courses = tempInstructor.getCourses();

    // break associations of all courses for instructor
    for (Course tempCourse : courses) {
        tempCourse.setInstructor(null);
    }

    // delete the instructor
    entityManager.remove(tempInstructor);
}
```

Remove the instructor from the courses

We only delete the instructor … not the associated course based on our cascade types

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Error message

- If you don't remove instructor from courses … **constraint violation**

```
Caused by: java.sql.SQLIntegrityConstraintViolationException:

Cannot delete or update a parent row: a foreign key constraint fails

(`hb-03-one-to-many`.`course`,
CONSTRAINT `FK_INSTRUCTOR` FOREIGN KEY (`instructor_id`) REFERENCES `instructor` (`id`))
```

- An instructor can not be deleted if it is referenced by a course
- You must remove the instructor from the course first

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Main app

File: CruddemoApplication.java

```
private void deleteInstructor(AppDAO appDAO) {

  int theId = 1;
  System.out.println("Deleting instructor id: " + theId);

  appDAO.deleteInstructorById(theId);

  System.out.println("Done!");
}
```


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@OneToMany: Delete Course

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Delete course

- Delete the course by ID

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Add new DAO method to delete course

File: AppDAOImpl.java

```
@Override
@Transactional
public void deleteCourseById(int theId) {

    // retrieve the course
    Course tempCourse = entityManager.find(Course.class, theId);

    // delete the course
    entityManager.remove(tempCourse);
}
```


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Main app

File: CruddemoApplication.java

```
private void deleteCourseById(AppDAO appDAO) {

  int theId = 10;
  System.out.println("Deleting course id: " + theId);

  appDAO.deleteCourseById(theId);

  System.out.println("Done!");

}
```


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@OneToMany: Uni-Directional

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One-to-Many Mapping

- A course can have many reviews
  - Uni-directional

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Real-World Project Requirement

- If you delete a course, also delete the reviews
- Reviews without a course … have no meaning

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@OneToMany

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Look Mom … our project is growing!

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Development Process: One-to-Many

Step-By-Step

1. Prep Work - Define database tables
2. Create **Review** class
3. Update **Course** class

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table: review

File: create-db.sql

comment:
"Wow … this course is awesome!"

```
CREATE TABLE `review` (

  `id` int(11) NOT NULL AUTO_INCREMENT,
  `comment` varchar(256) DEFAULT NULL,
  `course_id` int(11) DEFAULT NULL,

   ...
);
```

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table: review - foreign key

File: create-db.sql

```
CREATE TABLE `review` (
  …
  KEY `FK_COURSE_ID_idx` (`course_id`),
  CONSTRAINT `FK_COURSE`
  FOREIGN KEY (`course_id`)
  REFERENCES `course` (`id`)
  …
);
```

Table

Column

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table: course - no changes

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Step 2: Create Review class

```
@Entity
@Table(name="review")
public class Review {

    @Id
    @GeneratedValue(strategy=GenerationType.IDENTITY)
    @Column(name="id")
    private int id;

    @Column(name="comment")
    private String comment;

    ...
    // constructors, getters / setters
}
```

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Step 3: Update Course - reference reviews

```
@Entity
@Table(name="course")
public class Course {
   ...


   private List<Review> reviews;

   // getter / setters
   ...

}
```

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Add @OneToMany annotation

```
@Entity
@Table(name="course")
public class Course {
   ...

   @OneToMany
   @JoinColumn(name="course_id")
   private List<Review> reviews;

   // getter / setters
   ...

}
```

Refers to “course_id” column in “review” table

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More: @JoinColumn

- In this scenario, **@JoinColumn** tells Hibernate
  - Look at the **course_id** column in the **review** table
  - Use this information to help find associated reviews for a course

```
public class Course {
    ...

    @OneToMany
    @JoinColumn(name="course_id")
    private List<Review> reviews;
```

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Add support for Cascading

```
@Entity
@Table(name="course")
public class Course {
    ...

    @OneToMany(cascade=CascadeType.ALL)
    @JoinColumn(name="course_id")
    private List<Review> reviews;

    ...

}
```

Cascade all operations including deletes!

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Add support for Lazy loading

```
@Entity
@Table(name="course")
public class Course {
    ...

    @OneToMany(fetch=FetchType.LAZY, cascade=CascadeType.ALL)
    @JoinColumn(name="course_id")
    private List<Review> reviews;

    ...

}
```

Lazy load the reviews

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Add convenience method for adding review

```
@Entity
@Table(name="course")
public class Course {
   ...
   // add convenience methods for adding reviews

   public void add(Review tempReview) {

      if (reviews == null) {
         reviews = new ArrayList<>();
      }

      reviews.add(tempReview);

   }
   ...
}
```

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@ManyToMany

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Many-to-Many Mapping

- A course can have many students
- A student can have many courses

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Keep track of relationships

- Need to track which student is in which course and vice-versa

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Join Table

A table that provides a mapping between two tables.

It has foreign keys for each table
to define the mapping relationship.

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@ManyToMany

Join Table

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Join Table Example

Find John's Courses

- Pacman

Join Table

course

id	title	instructor_id
10	Pacman - How To Score One Million Points	NULL
11	Rubik's Cube - How to Speed Cube	NULL
12	Atari 2600 - Game Development	NULL
NULL	NULL	NULL

course_student

course_id	student_id
10	1
10	2
11	2
12	2
NULL	NULL

student

id	first_name	last_name	email
1	John	Doe	john@luv2code.com
2	Mary	Public	mary@luv2code.com
NULL	NULL	NULL	NULL

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Join Table Example

Find Mary's Courses

- Pacman
- Rubik's Cube
- Atari 2600

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Development Process: Many-to-Many

1. Prep Work - Define database tables
2. Update **Course** class
3. Update **Student** class

Step-By-Step

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join table: course_student

File: create-db.sql

```
CREATE TABLE `course_student` (

  `course_id` int(11) NOT NULL,
  `student_id` int(11) NOT NULL,

  PRIMARY KEY (`course_id`, `student_id`),

   ...
);
```

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join table: course_student - foreign keys

```
CREATE TABLE `course_student` (
  ...
  CONSTRAINT `FK_COURSE_05`
  FOREIGN KEY (`course_id`)
  REFERENCES `course` (`id`),

  CONSTRAINT `FK_STUDENT`
  FOREIGN KEY (`student_id`)
  REFERENCES `student` (`id`)
  ...
);
```

Table

Column

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join table: course_student - foreign keys

```
CREATE TABLE `course_student` (
  ...
  CONSTRAINT `FK_COURSE_05`
  FOREIGN KEY (`course_id`)
  REFERENCES `course` (`id`),

  CONSTRAINT `FK_STUDENT
  FORE (`student_i
  REFERENCES `student` (
  ...
);
```

Table

Column

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Step 2: Update Course - reference students

```
@Entity
@Table(name="course")
public class Course {
    ...


    private List<Student> students;

    // getter / setters
    ...

}
```

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Add @ManyToMany annotation

```
@Entity
@Table(name="course")
public class Course {
   ...

   @ManyToMany
   @JoinTable(
         name="course_student",
         joinColumns=@JoinColumn(name="course_id"),
         inverseJoinColumns=@JoinColumn(name="student_id")
         )
   private List<Student> students;

   // getter / setters
   ...

}
```

Refers to “course_id” column in “course_student” join table

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Add @ManyToMany annotation

```
@Entity
@Table(name="course")
public class Course {
   ...

   @ManyToMany
   @JoinTable(
         name="course_student",
         joinColumns=@JoinColumn(name="course_id"),
         inverseJoinColumns=@JoinColumn(name="student_id")
         )
   private List<Student> students;

   // getter / setters
   ...

}
```

Refers to “student_id” column in “course_student” join table

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More: @JoinTable

- **@JoinTable** tells Hibernate
  - Look at the **course_id** column in the **course_student** table
  - For other side (inverse), look at the **student_id** column in the **course_student** table
  - Use this information to find relationship between **course** and **students**

```
public class Course {

    @ManyToMany
    @JoinTable(
            name="course_student",
            joinColumns=@JoinColumn(name="course_id"),
            inverseJoinColumns=@JoinColumn(name="student_id")
            )
    private List<Student> students;

}
```

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More on "inverse"

- In this context, we are defining the relationship in the **Course** class
- The **Student** class is on the "other side" … so it is considered the "inverse"
- "Inverse" refers to the "other side" of the relationship

We are here

Inverse / other side

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More on "inverse"

- In this context, we are defining the relationship in the **Course** class
- The **Student** class is on the "other side" … so it is considered the "inverse"
- "Inverse" refers to the "other side" of the relationship

We are here

Inverse / other side

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Owning Side and Inverse / Non-Owning Side

- Every many-to-many association has two sides:
  - The owning side and the inverse / non-owning side
- If the association is bidirectional
  - Either side may be designated as the owning side
  - The non-owning side must use the **mappedBy** element of the **ManyToMany** annotation
  - To specify the relationship field or property of the owning side

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Owning Side and Inverse / Non-Owning Side

Owning Side

Inverse / Non-Owning Side

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Now, let’s update the mapping for the Student

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Step 3: Update Student - reference courses

```
@Entity
@Table(name="student")
public class Student {
    ...


    private List<Course> courses;

    // getter / setters
    ...

}
```

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Add @ManyToMany annotation

```
@Entity
@Table(name="student")
public class Student {
   ...

   @ManyToMany(mappedBy="students")
   private List<Course> courses;

   // getter / setters
   ...

}
```

Refers to “students” property in “Course” class

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More: mappedBy

```
public class Student {
    ...

    @ManyToMany(mappedBy="students")
    private List<Course> courses;
```

- **mappedBy** tells Hibernate
  - Look at the students property in the Course class
  - Use information from the Course class @JoinTabe
  - To help find associated courses for student

```
public class Course {

    @ManyToMany
    @JoinTable(
            name="course_student",
            joinColumns=@JoinColumn(name="course_id"),
            inverseJoinColumns=@JoinColumn(name="student_id")
            )
    private List<Student> students;

}
```


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Real-World Project Requirement

- If you delete a course, DO NOT delete the students

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Other features

- In the next set of videos, we'll add support for other features

- **Lazy Loading** of students and courses

- **Cascading** to handle cascading saves … but NOT deletes
  - If we delete a course, DO NOT delete students
  - If we delete a student, DO NOT delete courses

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