CS544

LESSON 4
JPA MAPPING 1

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
November 28 **Lesson 1** Introduction Spring framework Dependency injection	November 29 **Lesson 2** Spring Boot AOP	November 30 **Lesson 3** JDBC JPA	December 1 **Lesson 4** JPA mapping 1	December 2 **Lesson 5** JPA mapping 2	December 3 **Lesson 6** JPA queries	December 4
December 5 **Lesson 7** Transactions	December 6 **Lesson 8** MongoDB	December 7 **Midterm Review**	December 8 **Midterm exam**	December 9 **Lesson 9** REST webservices	December 10 **Lesson 10** SOAP webservices	December 11
December 12 **Lesson 11** Messaging	December 13 **Lesson 12** Scheduling Events Configuration	December 14 **Lesson 13** Monitoring	December 15 **Lesson 14** Testing your application	December 16 **Final review**	December 17 **Final exam**	December 18
December 19 **Project**	December 20 **Project**	December 21 **Project**	December 22 **Presentations**			

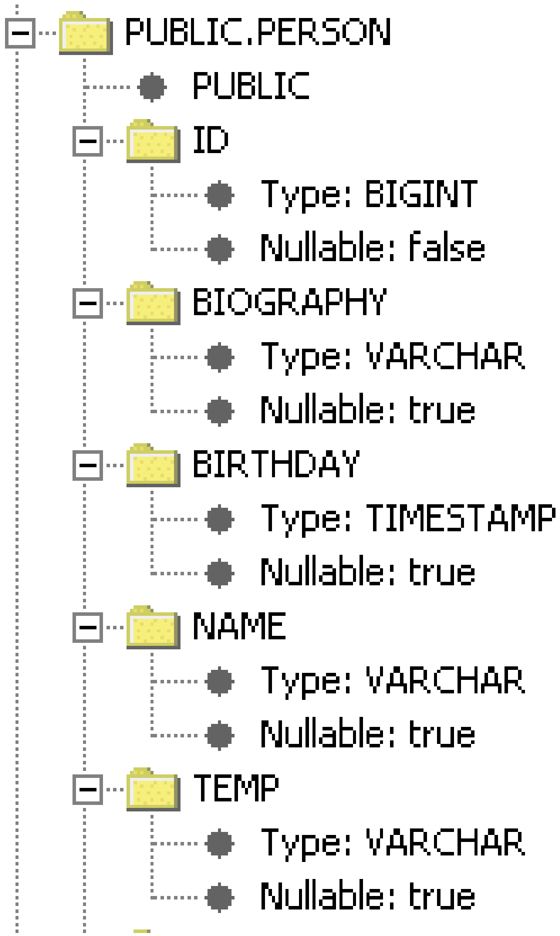
MAPPING DATA TYPES

Annotation Types

- Use @Column to specify more details
- Use @Temporal to specify how a Date should be persisted (DATE, TIME or TIMESTAMP)
- Use @Lob to indicate Large values
- Use @Transient to indicate that a property should ***not*** be persisted

Default mapping

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private long id;
  private String name;
  private Date birthday;
  private String biography;
  private String temp;

  ...
```



```
PUBLIC.PERSON
    PUBLIC
    ID
        Type: BIGINT
        Nullable: false
    BIOGRAPHY
        Type: VARCHAR
        Nullable: true
    BIRTHDAY
        Type: TIMESTAMP
        Nullable: true
    NAME
        Type: VARCHAR
        Nullable: true
    TEMP
        Type: VARCHAR
        Nullable: true
```

Specify different mapping

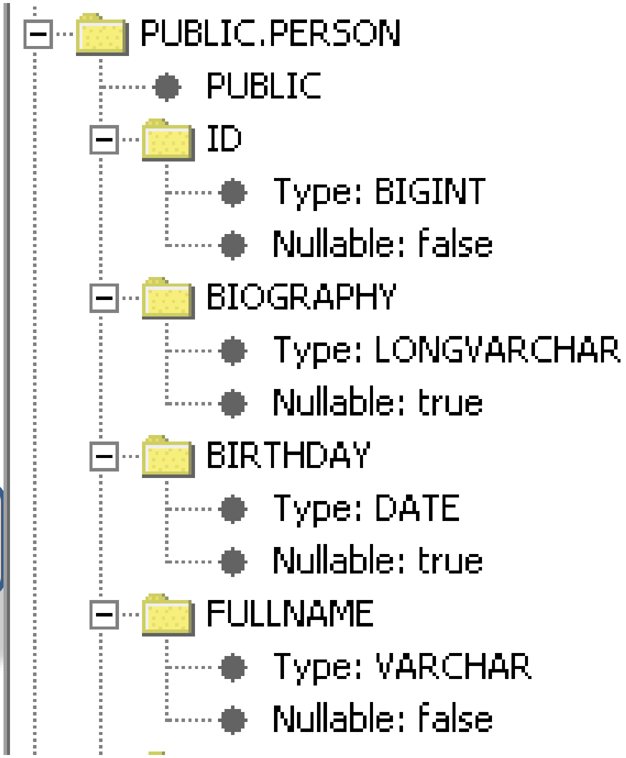
```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private long id;
  @Column(name="FULLNAME", length=255, nullable=false)
  private String name;
  @Temporal(TemporalType.DATE)
  private Date birthday;
  @Lob
  private String biography;
  @Transient
  private String temp;

  ...
```

Name will be stored as:
FULLNAME VARCHAR(255) NOT NULL

Birthday will be stored as a Date

Biography will be stored as CLOB instead of VARCHAR

Temp will not be stored in the database



```
PUBLIC.PERSON
  PUBLIC
  ID
    Type: BIGINT
    Nullable: false
  BIOGRAPHY
    Type: LONGVARCHAR
    Nullable: true
  BIRTHDAY
    Type: DATE
    Nullable: true
  FULLNAME
    Type: VARCHAR
    Nullable: false
```

Property or Field Access

- JPA can access objects in two ways
  - property access gets and sets object values through getter /setter methods
  - field access gets and sets object values directly from / to the fields

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private long id;
  private String name;

  ...
```

JPA field access

```
@Entity
public class Person {
  private long id;
  private String name;

  public Person() {}
  public Person(String name) { this.name = name; }

  @Id
  @GeneratedValue
  public long getId() { return id; }
  private void setId(long id) { this.id = id; }
  public String getName() { return name; }
  public void setName(String name) { this.name = name; }
}
```

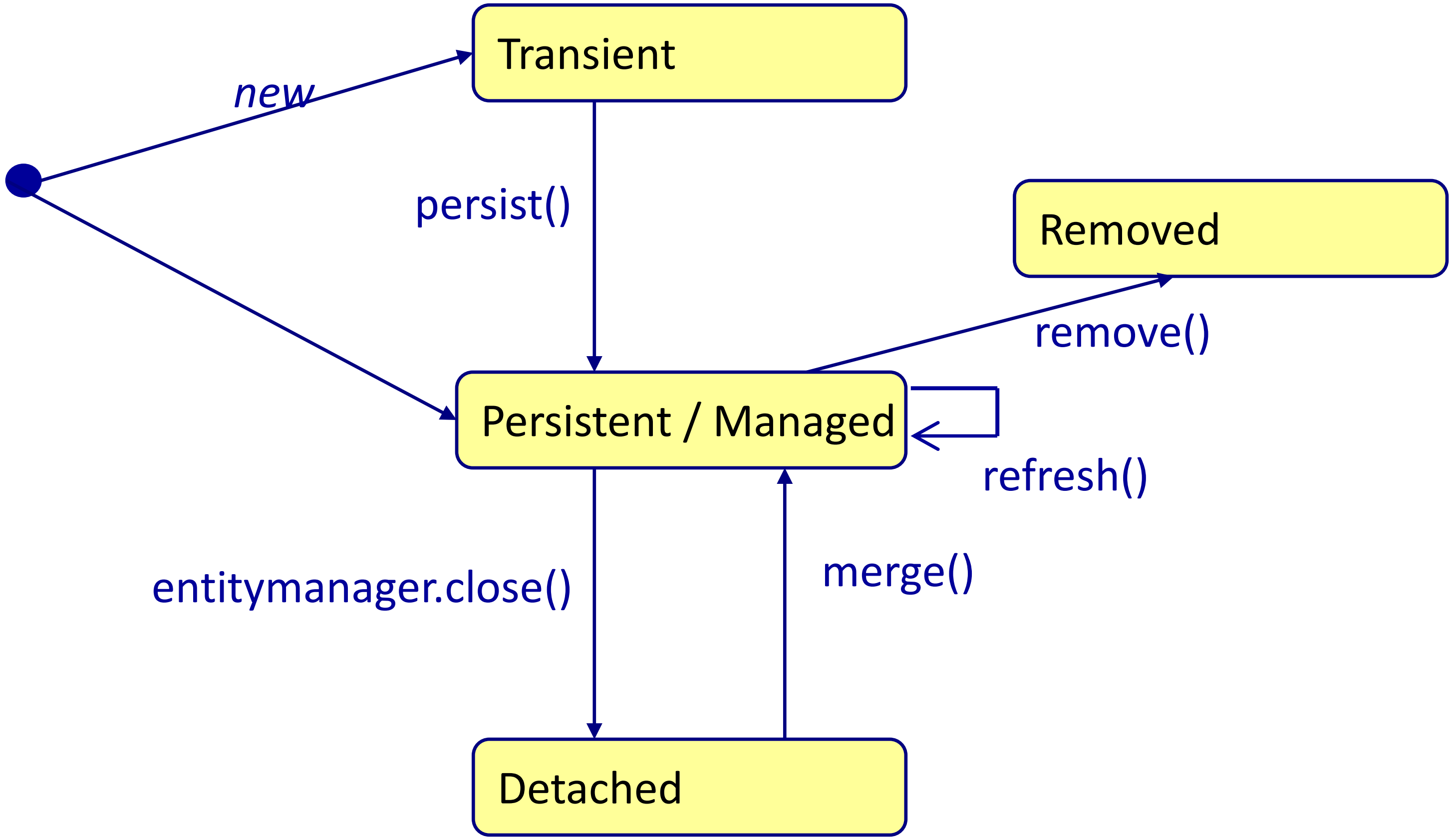
JPA property access

Specifying Access with Annotations

- The JPA specification lets you set the Access Type with the location of @Id
  - Placing @Id on a field specifies field access for the entire object
    - All other annotations should be on the fields
  - Placing @Id on a getter specifies property access for the entire object
    - All other annotations should be on the getters

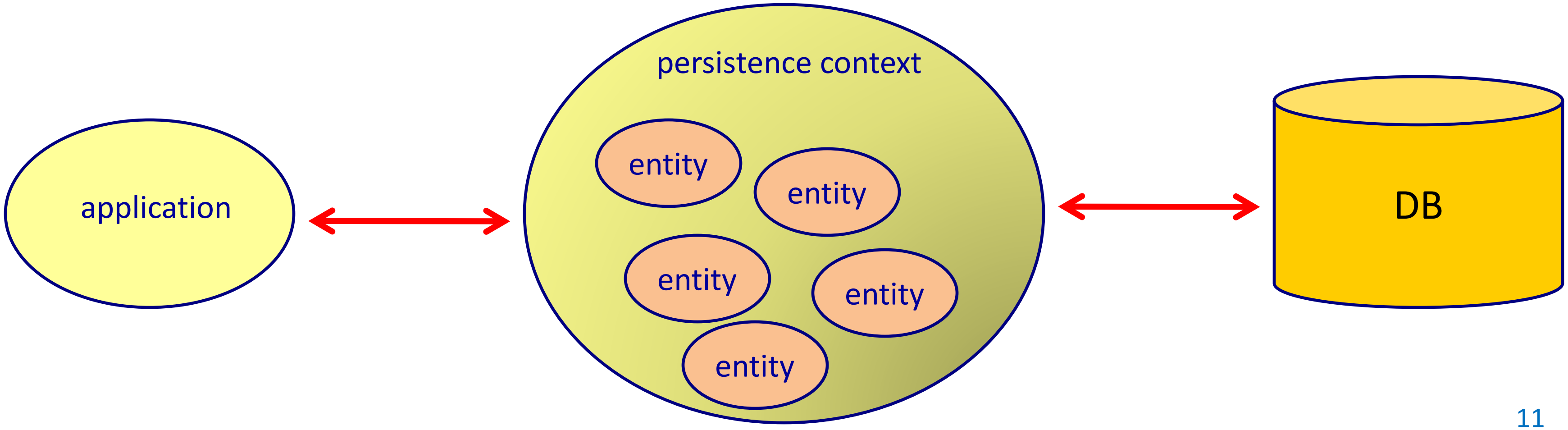
ENTITY OBJECT LIFECYCLE

JPA lifecycle of an entity



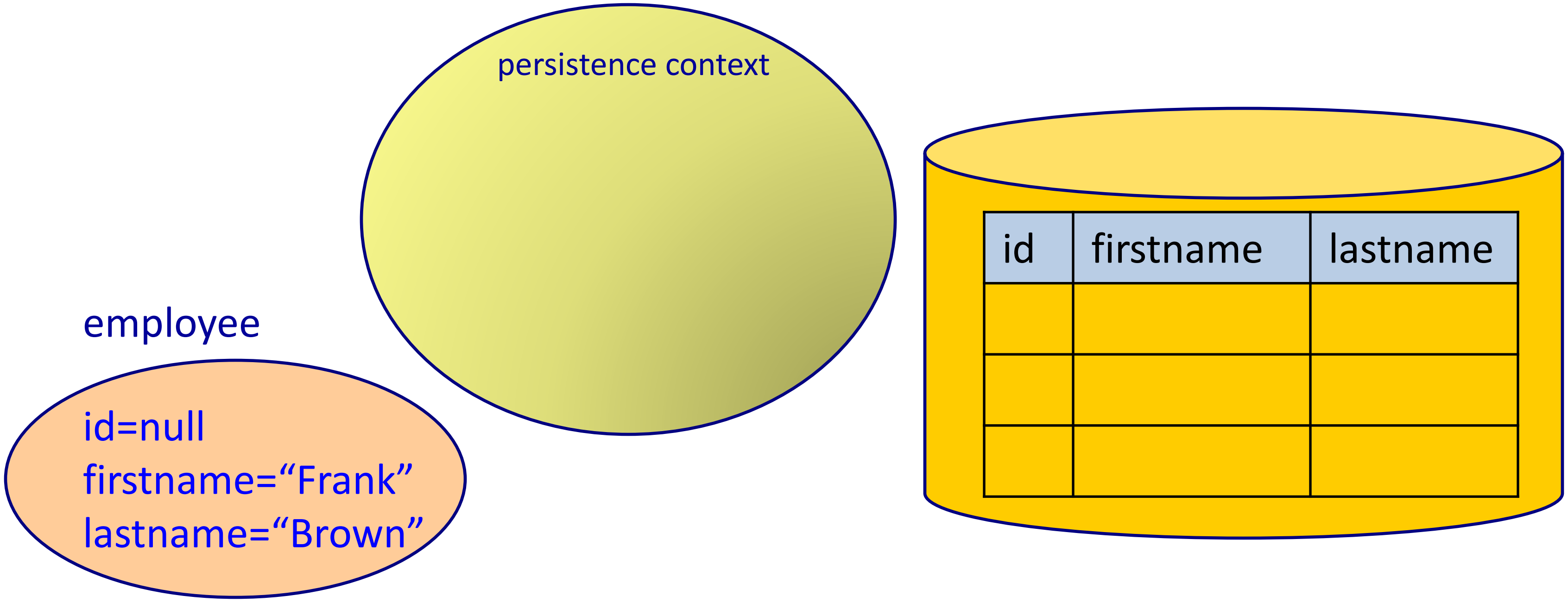
Persistence context

- Manages the entities
- Guarantees that managed enities will be saved in the database
- Tracks changes until they are pushed to the database
- Works like a cache



Transient entity

- A transient entity has no database identity

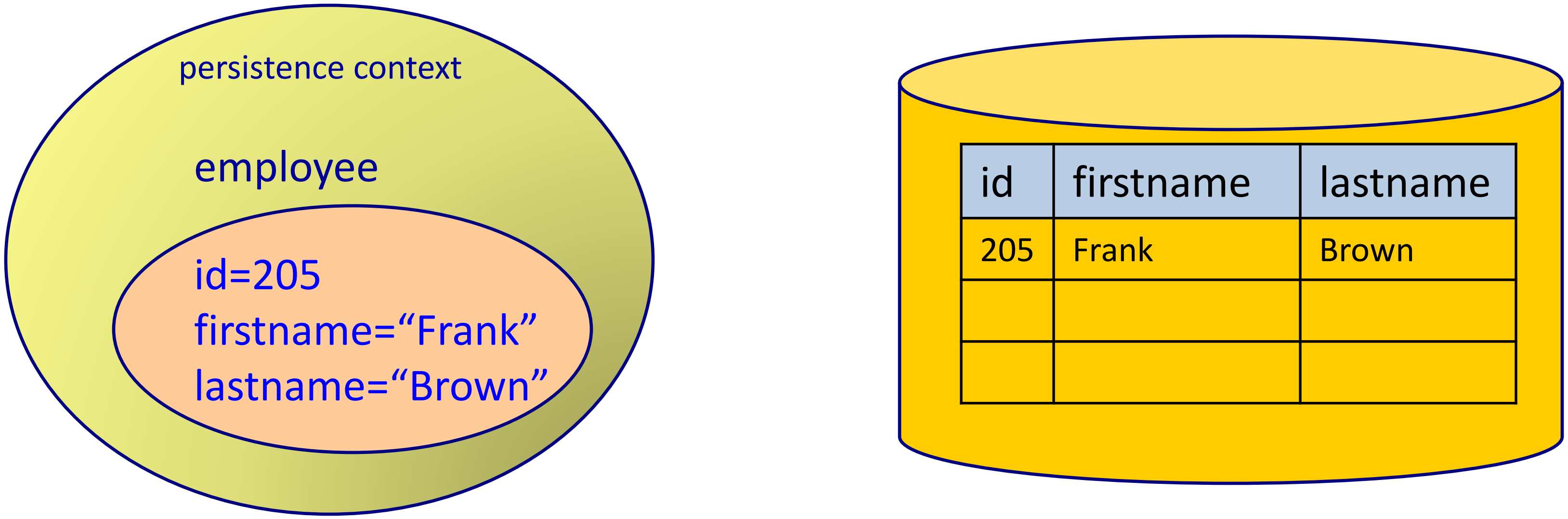


id=null
firstname="Frank"
lastname="Brown"

id	firstname	lastname

Managed entity

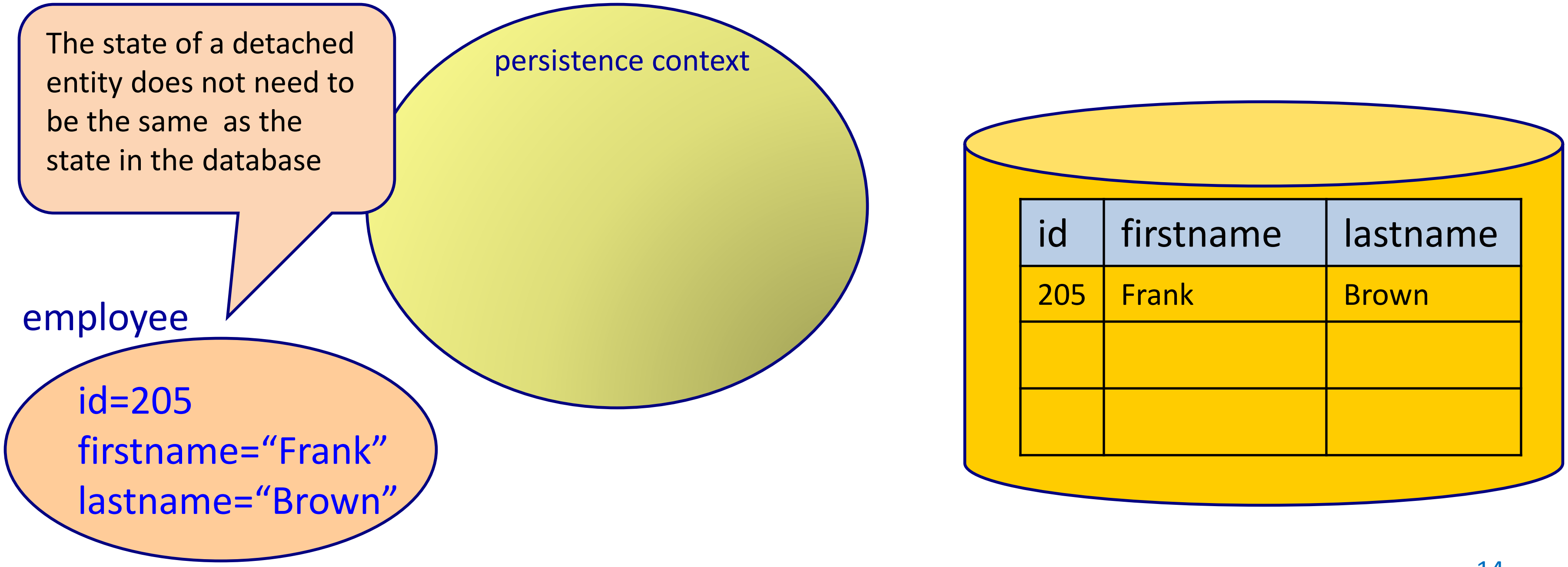
- A managed entity is managed by the persistence context and has a database identity



id	firstname	lastname
205	Frank	Brown

Detached entity

- A detached entity has a database identity, but is not managed by the current persistence context



The state of a detached entity does not need to be the same as the state in the database

persistence context

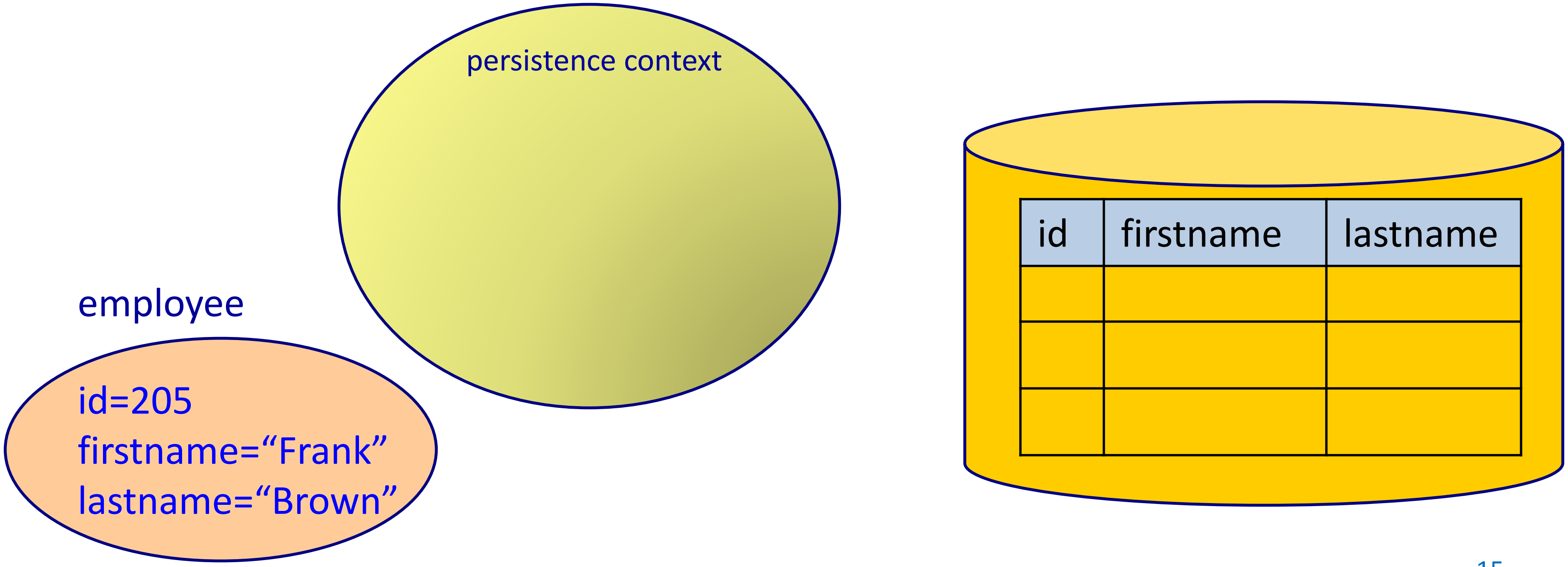
employee

id=205
firstname="Frank"
lastname="Brown"

id	firstname	lastname
205	Frank	Brown

Removed entity

- With a removed entity is the corresponding data removed from the database.



id	firstname	lastname

Association Mapping

ASSOCIATION MAPPING

Association Mapping

- In Java associations are made with object references

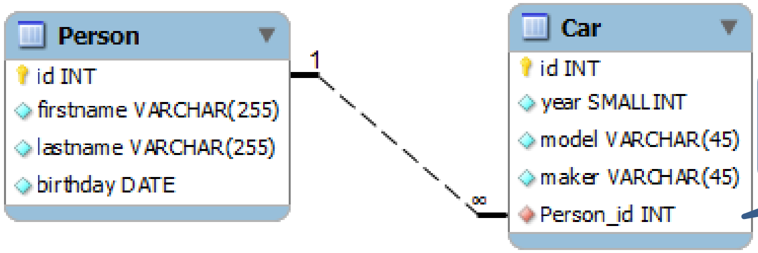
Person has a cars collection of references

```
public class Person {
  private int id;
  private String firstname;
  private String lastname;
  private List<Car> cars
    = new ArrayList<Car>();

  ...
```

```
public class Car {
  private int id;
  private short year;
  private String model;
  private String maker;
  private Person owner;

  ...
```

Car also has an owner reference back to its owner

- In a relational schema associations are made with Foreign keys



Person
id INT
firstname VARCHAR(255)
lastname VARCHAR(255)
birthday DATE

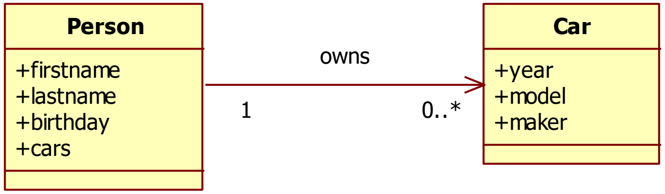
Car
id INT
year SMALLINT
model VARCHAR(45)
maker VARCHAR(45)
Person_id INT

Car has a foreign key to Person

- O/R Mapping translates references into foreign keys and visa versa.

OO Association Directionality

- Uni-directional association



Can only be traversed from person to car

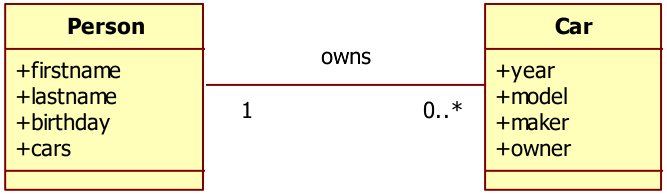
Person has a collection of references to Car objects

```
public class Person {
  private int id;
  private String firstname;
  private String lastname;
  private List<Car> cars
    = new ArrayList<Car>();

  ...
```

```
public class Car {
  private int id;
  private short year;
  private String model;
  private String maker;

  ...
```

Car does not have a reference back to person

- Bi-directional association



Association can be traversed in both directions

Person has a collection of references to Car objects

```
public class Person {
  private int id;
  private String firstname;
  private String lastname;
  private List<Car> cars
    = new ArrayList<Car>();

  ...
```

```
public class Car {
  private int id;
  private short year;
  private String model;
  private String maker;
  private Person owner;

  ...
```

Car also has a reference back to person

MANY TO ONE ASSOCIATIONS

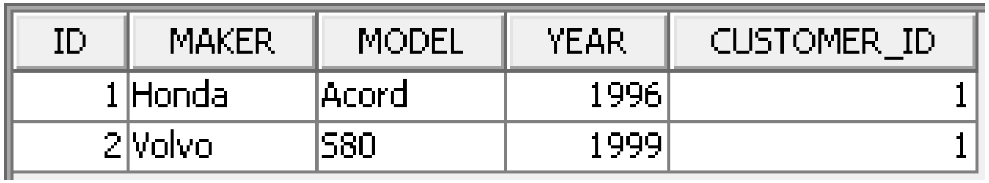
Uni-Directional Many to One default mapping

```
@Entity
public class Car {
  @Id
  @GeneratedValue
  private int id;
  private short year;
  private String model;
  private String maker;
  @ManyToOne
  private Customer customer;

  ...
```

@ManyToOne

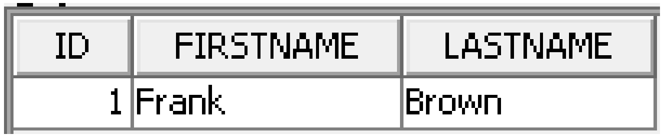
```
@Entity
public class Customer {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;

  ...
```

CAR table



ID	MAKER	MODEL	YEAR	CUSTOMER_ID
1	Honda	Acord	1996	1
2	Volvo	S80	1999	1

CUSTOMER table



ID	FIRSTNAME	LASTNAME
1	Frank	Brown

Use a foreign key column

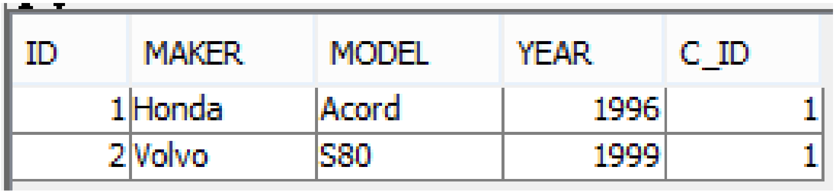
Uni-Directional Many to One with JoinColumn

```
@Entity
public class Car {
   @Id
   @GeneratedValue
   private int id;
   private short year;
   private String model;
   private String maker;
   @ManyToOne
   @JoinColumn(name="c_id")
   private Customer customer;

   ...
```

JoinColumn

```
@Entity
public class Customer {
   @Id
   @GeneratedValue
   private int id;
   private String firstname;
   private String lastname;

   ...
```

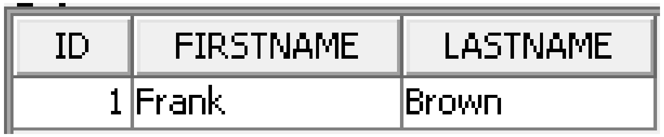
CAR table



ID	MAKER	MODEL	YEAR	C_ID
1	Honda	Acord	1996	1
2	Volvo	S80	1999	1

Use a foreign key column

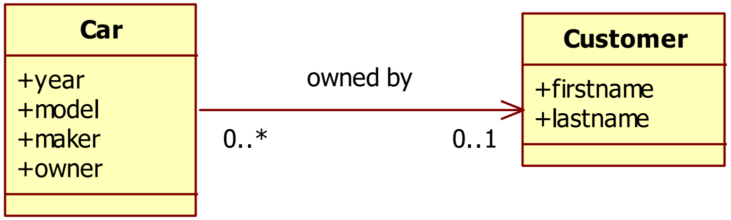
CUSTOMER table



ID	FIRSTNAME	LASTNAME
1	Frank	Brown

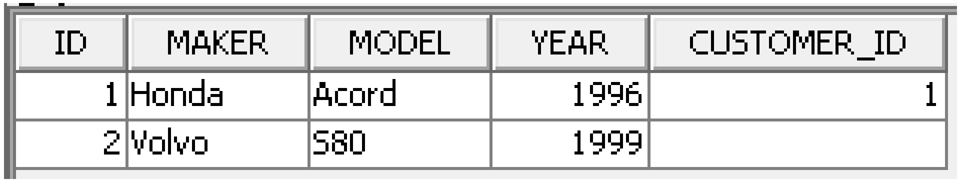
Optional Associations

- Optional associations are associations that may not exist
  - A Car can exist without a Customer



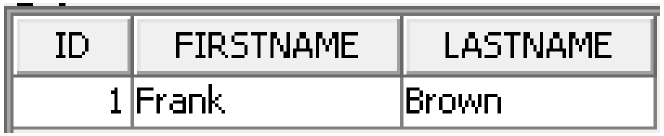
0..1 indicates that the customer association is optional

CAR table



ID	MAKER	MODEL	YEAR	CUSTOMER_ID
1	Honda	Acord	1996	1
2	Volvo	S80	1999	

CUSTOMER table



ID	FIRSTNAME	LASTNAME
1	Frank	Brown

To facilitate this CUSTOMER_ID would have to be nullable

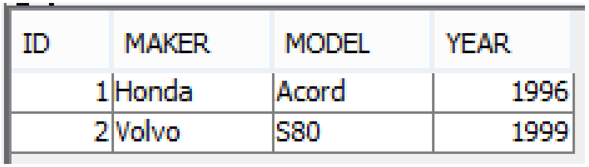
Uni-Directional Many to One with JoinTable

```
@Entity
public class Car {
   @Id
   @GeneratedValue
   private int id;
   private short year;
   private String model;
   private String maker;
   @ManyToOne
   @JoinTable(name="car_cust")
   private Customer customer;

   ...
```

JoinTable

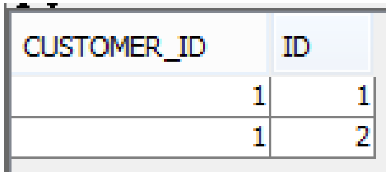
```
@Entity
public class Customer {
   @Id
   @GeneratedValue
   private int id;
   private String firstname;
   private String lastname;

   ...
```

CAR table



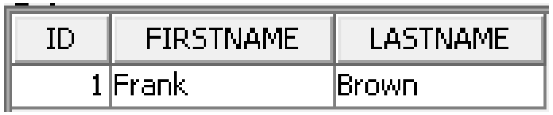
ID	MAKER	MODEL	YEAR
1	Honda	Acord	1996
2	Volvo	S80	1999

CAR_CUST table



CUSTOMER_ID	ID
1	1
1	2

CUSTOMER table



ID	FIRSTNAME	LASTNAME
1	Frank	Brown

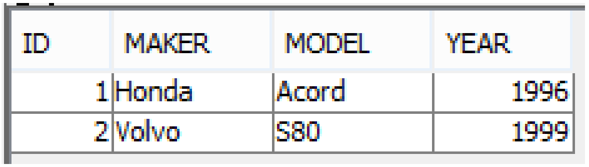
Uni-Directional Many to One with JoinTable

```
@Entity
public class Car {
  @Id
  @GeneratedValue
  private int id;
  private short year;
  private String model;
  private String maker;
  @ManyToOne
  @JoinTable(name = "car_cust",
    joinColumns = { @JoinColumn(name = "car_id") },
    inverseJoinColumns = { @JoinColumn(name = "cust_id") })
  private Customer customer;

  ...
```

JoinTable

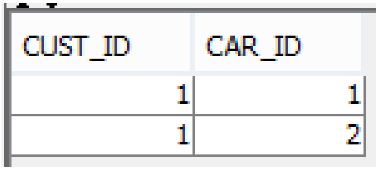
```
@Entity
public class Customer {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;

  ...
```

CAR table



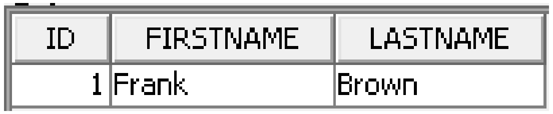
ID	MAKER	MODEL	YEAR
1	Honda	Acord	1996
2	Volvo	S80	1999

CAR_CUST table



CUST_ID	CAR_ID
1	1
1	2

CUSTOMER table



ID	FIRSTNAME	LASTNAME
1	Frank	Brown

Mapping Summary

```
@ManyToOne
```

Default mapping
uses joincolumn

```
@ManyToOne
@JoinColumn(name="c_id")
```

```
@ManyToOne
@JoinTable(name="car_cust")
```

ONE TO MANY ASSOCIATIONS

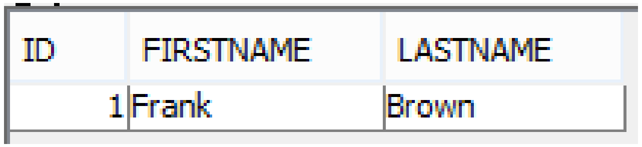
Uni-directional One to Many default mapping

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToMany
  private List<Car> cars = new ArrayList<Car>();

  ...
```

@OneToMany

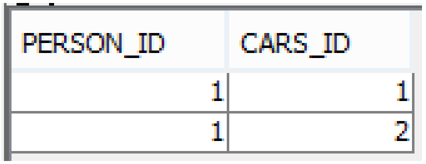
```
@Entity
public class Car {
  @Id
  @GeneratedValue
  private int id;
  private short year;
  private String model;
  private String maker;

  ...
```

PERSON table



ID	FIRSTNAME	LASTNAME
1	Frank	Brown

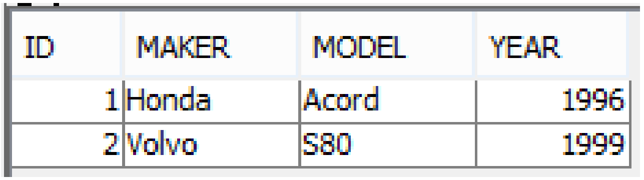
PERSON_CAR table



PERSON_ID	CARS_ID
1	1
1	2

Use a link table

CAR table



ID	MAKER	MODEL	YEAR
1	Honda	Acord	1996
2	Volvo	S80	1999

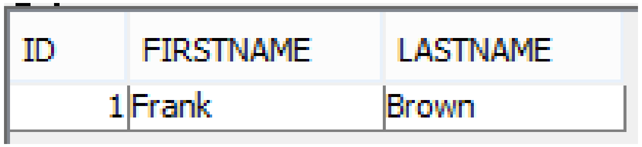
Uni-directional One to Many with JoinColumn

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToMany
  @JoinColumn(name="p_id")
  private List<Car> cars = new ArrayList<Car>();

  ...
```

@JoinColumn

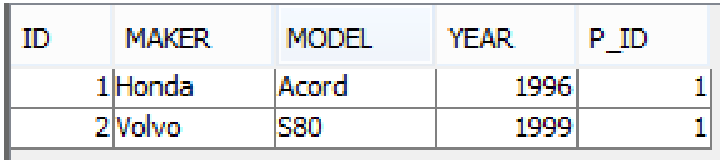
```
@Entity
public class Car {
  @Id
  @GeneratedValue
  private int id;
  private short year;
  private String model;
  private String maker;

  ...
```

PERSON table



ID	FIRSTNAME	LASTNAME
1	Frank	Brown

CAR table



ID	MAKER	MODEL	YEAR	P_ID
1	Honda	Acord	1996	1
2	Volvo	S80	1999	1

Use a foreign key column

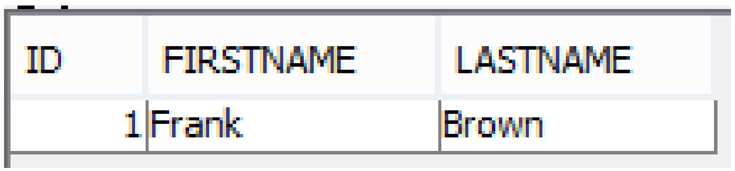
Uni-directional One to Many with JoinTable

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToMany
  @JoinTable(name = "pers_car",
      joinColumns = { @JoinColumn(name = "p_id") },
      inverseJoinColumns = { @JoinColumn(name = "c_id") }
  )
  private List<Car> cars = new ArrayList<Car>();

  ...
```

@JoinTable

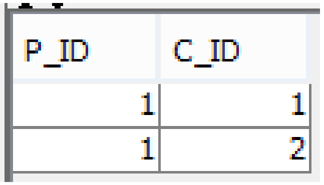
```
@Entity
public class Car {
  @Id
  @GeneratedValue
  private int id;
  private short year;
  private String model;
  private String maker;

  ...
```

PERSON table



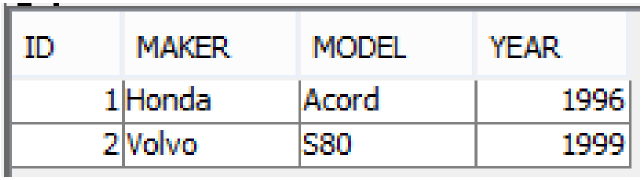
ID	FIRSTNAME	LASTNAME
1	Frank	Brown

PERS_CAR table



P_ID	C_ID
1	1
1	2

CAR table



ID	MAKER	MODEL	YEAR
1	Honda	Acord	1996
2	Volvo	S80	1999

Use a link table

Many to One / One to Many (Bi)

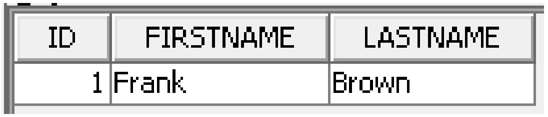
```
@Entity
public class Person {
   @Id
   @GeneratedValue
   private int id;
   private String firstname;
   private String lastname;
   @OneToMany
   @JoinColumn(name="person_id")
   private List<Car> cars =
             new ArrayList<Car>();

   ...
```

This OneToMany association is stored in the foreign key column with name 'person_id' in the CAR table

```
@Entity
public class Car {
   @Id
   @GeneratedValue
   private int id;
   private short year;
   private String model;
   private String maker;
   @ManyToOne
   @JoinColumn(name="owner_id")
   private Person owner;

   ...
```

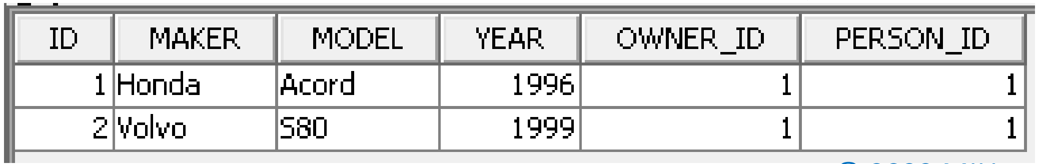
This ManyToOne association is stored in the foreign key column with name 'owner_id' in the CAR table

PERSON table



ID	FIRSTNAME	LASTNAME
1	Frank	Brown

CAR table



ID	MAKER	MODEL	YEAR	OWNER_ID	PERSON_ID
1	Honda	Acord	1996	1	1
2	Volvo	S80	1999	1	1

Hibernate sees this bi-directional association as 2 independent associations

Both FK column contain the same information

mappedBy

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToMany(mappedBy="owner")
  private List<Car> cars =
             new ArrayList<Car>();

  ...
```

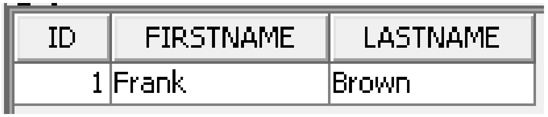
mappedby indicates that the FK is on the other side

```
@Entity
public class Car {
  @Id
  @GeneratedValue
  private int id;
  private short year;
  private String model;
  private String maker;
  @ManyToOne
  @JoinColumn(name="owner_id")
  private Person owner;

  ...
```

Optional @JoinColumn to specify FK

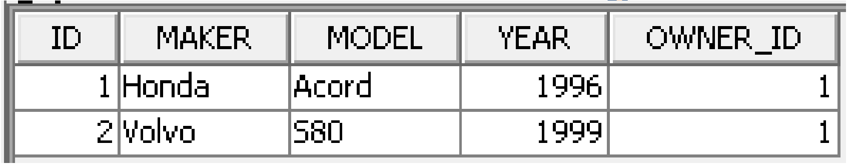
The bi-directional association is stored in one FK column

PERSON table



ID	FIRSTNAME	LASTNAME
1	Frank	Brown

CAR table



ID	MAKER	MODEL	YEAR	OWNER_ID
1	Honda	Acord	1996	1
2	Volvo	S80	1999	1

Mapping Summary

```
@ManyToOne
```

Default mapping
uses joincolumn

```
@ManyToOne
@JoinColumn(name="c_id")
```

```
@ManyToOne
@JoinTable(name="car_cust")
```

```
@OneToMany
```

Default mapping
uses jointable

```
@OneToMany
@JoinColumn(name="p_id")
```

```
@OneToMany
@JoinTable(name="pers_car")
```

BI-directional: Use `@MappedBy` on the many side

ONE TO ONE ASSOCIATIONS

OneToOne with annotations

- JPA does not support a real OneToOne

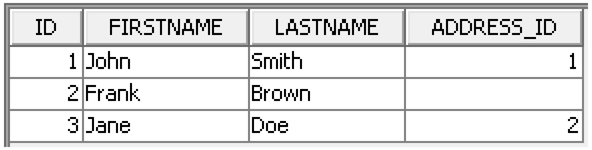
```
@Entity
public class Customer {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToOne
  private Address address;

  ...
```

@OneToOne

```
@Entity
public class Address {
  @Id
  @GeneratedValue
  private int id;
  private String street;
  private String suiteOrApt;
  private String city;
  private String state;
  private String zip;

  ...
```

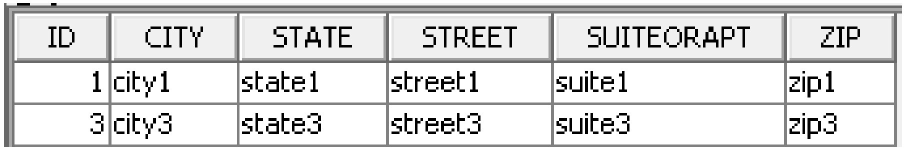
- This mapping results in a ManyToOne

CUSTOMER table



ID	FIRSTNAME	LASTNAME	ADDRESS_ID
1	John	Smith	1
2	Frank	Brown	
3	Jane	Doe	2

ADDRESS table



ID	CITY	STATE	STREET	SUITEORAPT	ZIP
1	city1	state1	street1	suite1	zip1
3	city3	state3	street3	suite3	zip3

Workaround: @PrimaryKeyJoinColumn

```
@Entity
public class Customer {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToOne
  @PrimaryKeyJoinColumn
  private Address address;

 ...
```

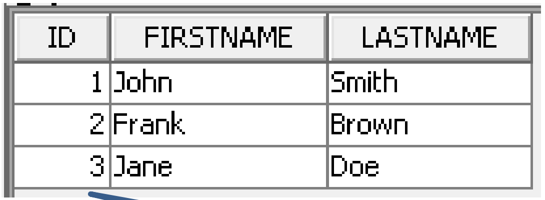
@PrimaryKeyJoinColumn
Join on PK value

Primary key value not generated

```
@Entity
public class Address {
  @Id
  private int id;
  private String street;
  private String suiteOrApt;
  private String city;
  private String state;
  private String zip;

 ...
```

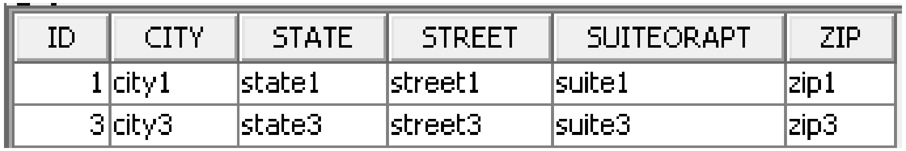
Id has to be set manually

CUSTOMER table



ID	FIRSTNAME	LASTNAME
1	John	Smith
2	Frank	Brown
3	Jane	Doe

ADDRESS table



ID	CITY	STATE	STREET	SUITEORAPT	ZIP
1	city1	state1	street1	suite1	zip1
3	city3	state3	street3	suite3	zip3

Shared primary key

Mapping Summary

`@ManyToOne`

Default mapping
uses joincolumn

```
@ManyToOne
@JoinColumn(name="c_id")
```

```
@ManyToOne
@JoinTable(name="car_cust")
```

`@OneToMany`

Default mapping
uses jointable

```
@OneToMany
@JoinColumn(name="p_id")
```

```
@OneToMany
@JoinTable(name="pers_car")
```

`@OneToOne`

Same as `@ManyToOne`
Do not use `@PrimaryKeyJoinColumn`

BI-directional: Use `@MappedBy` on the many side

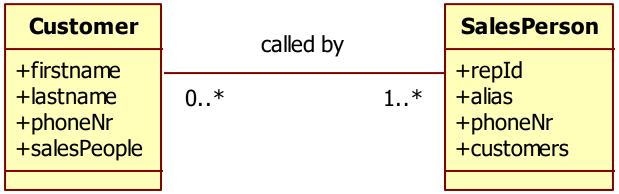
MANY TO MANY ASSOCIATIONS

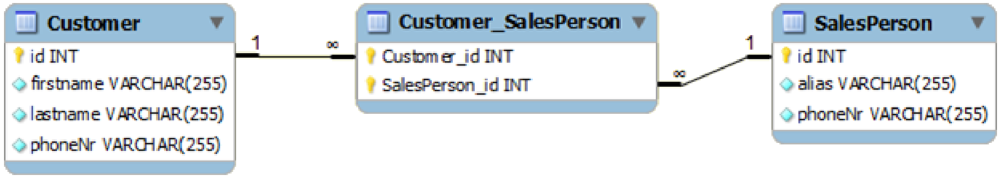
Many to Many Bi-directional

```
@Entity
public class Customer {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  private String phoneNr;
  @ManyToMany
  @JoinTable(name = "Customer_SalesPerson",
    joinColumns = { @JoinColumn(name = "Customer_id") },
    inverseJoinColumns = { @JoinColumn(name = "SalesPerson_id") }
  )
  private List<SalesPerson> salesPeople = new ArrayList<SalesPerson>();

  ...
```

@ManyToMany

@JoinTable is optional





```
@Entity
public class SalesPerson {
  @Id
  @GeneratedValue
  private int id;
  private String alias;
  private String phoneNr;
  @ManyToMany(mappedBy="salesPeople")
  private List<Customer> customers =
          new ArrayList<Customer>();

  ...
```

mappedBy specifies that the other side is the owning side

Mapping Summary

```
@ManyToOne
```

Default mapping
uses joincolumn

```
@ManyToOne
@JoinColumn(name="c_id")
```

```
@ManyToOne
@JoinTable(name="car_cust")
```

```
@OneToMany
```

Default mapping
uses jointable

```
@OneToMany
@JoinColumn(name="p_id")
```

```
@OneToMany
@JoinTable(name="pers_car")
```

```
@OneToOne
```

Same as `@ManyToOne`
Do not use `@PrimaryKeyJoinColumn`

```
@ManyToMany
```

Default mapping
uses jointable

```
@ManyToMany
@JoinTable(name = "Customer_SalesPerson")
```

BI-directional: Use `@MappedBy` on the many side

ASSOCIATION CASCADES

Association Cascades

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToMany(mappedBy="owner")
  private List<Car> cars =
            new ArrayList<Car>();

  ...
```

```
@Entity
public class Car {
  @Id
  @GeneratedValue
  private int id;
  private short year;
  private String model;
  private String maker;
  @ManyToOne
  @JoinColumn(name="owner_id")
  private Person owner;

  ...
```

- By default JPA does not cascade
  - During a session.persist(person) its car(s) will not be persisted
  - During a session.update(person) its car(s) will not be updated
  - During a session.delete(person) its car(s) will not be deleted

Specifying Cascades

- Each association tag has a cascade attribute

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToMany(cascade=CascadeType.PERSIST)
  private List<Car> cars = new ArrayList<Car>();

  ...
```

Association will cascade on Persist operations

When a person is persisted its cars will also be persisted

- Specify an array of cascade types:

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToMany(cascade={CascadeType.PERSIST, CascadeType.MERGE})
  private List<Car> cars = new ArrayList<Car>();

  ...
```

Cascade on persist and Merge

Cascade Types

JPA	Description
ALL	Cascade on all operations
PERSIST	Cascade on persist operations
MERGE	Cascade on merge operations
REMOVE	Cascade on remove operations
REFRESH	Cascade on refresh operations

Mapping Summary

@ManyToOne Default mapping uses joincolumn	@ManyToOne @JoinColumn(name="c_id")	@ManyToOne @JoinTable(name="car_cust")
@OneToMany Default mapping uses jointable	@OneToMany @JoinColumn(name="p_id")	@OneToMany @JoinTable(name="pers_car")
@OneToOne	Same as @ManyToOne Do not use @PrimaryKeyJoinColumn	
@ManyToMany Default mapping uses jointable	@ManyToMany @JoinTable(name = "Customer_SalesPerson")	
BI-directional:	Use @MappedBy on the many side	
Cascading:	By default no cascading @OneToMany(cascade=CascadeType.*PERSIST*)	

Main point

- One of the important aspects of using JPA is creating the correct mapping between the classes and the tables in the database.

Science of Consciousness: Transcendental Meditation settles the mind, allowing one to select the right tool for the specific situation at hand, allowing you to do less and accomplish more.

JPA default fetching

- @OneToOne defaults to eager loading
- @ManyToOne defaults to eager loading
- @OneToMany defaults to lazy loading
- @ManyToMany defaults to lazy loading

Changing the default fetching

```
@Entity
public class Course {
    @Id
    private String courseNumber;
    private String name;
    @OneToMany(fetch=FetchType.EAGER)
    @JoinColumn(name="courseid")
    private Collection<Student> students = new ArrayList<Student>();
```

Eager fetching

COLLECTION MAPPING

Collections

- Java collections:
  - Not ordered List (= Bag)
  - Set
  - List
  - Map

Mapping a not ordered List (1)

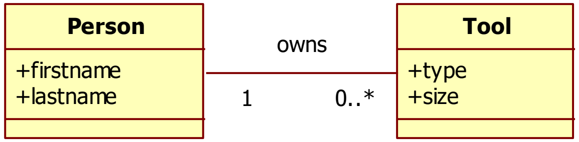
```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToMany(mappedBy="owner", cascade=CascadeType.PERSIST)
  private Collection<Tool> tools = new ArrayList<Tool>();
```

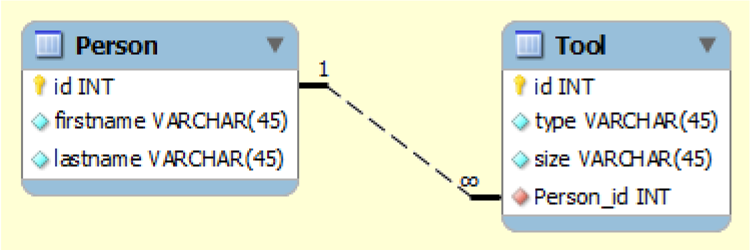
Hibernate will map a Collection as a Bag

We use an ArrayList since there is no official java Bag implementation

```
@Entity
public class Tool {
  @Id
  @GeneratedValue
  private int id;
  private String type;
  private String size;
  @ManyToOne
  private Person owner;

  ...
```

We've mapped this collection as a bi-directional one to many





Mapping a not ordered List (2)

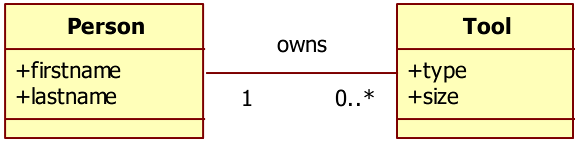
```
@Entity
public class Person {
   @Id
   @GeneratedValue
   private int id;
   private String firstname;
   private String lastname;
   @OneToMany(mappedBy="owner", cascade=CascadeType.PERSIST)
   private List<Tool> tools = new ArrayList<Tool>();
```

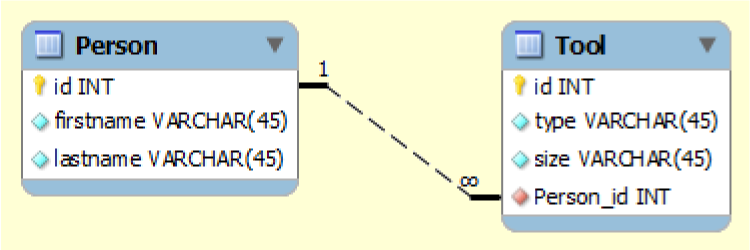
By default List also maps to a Bag

ArrayList is the most common List implementation

```
@Entity
public class Tool {
   @Id
   @GeneratedValue
   private int id;
   private String type;
   private String size;
   @ManyToOne
   private Person owner;

   ...
```

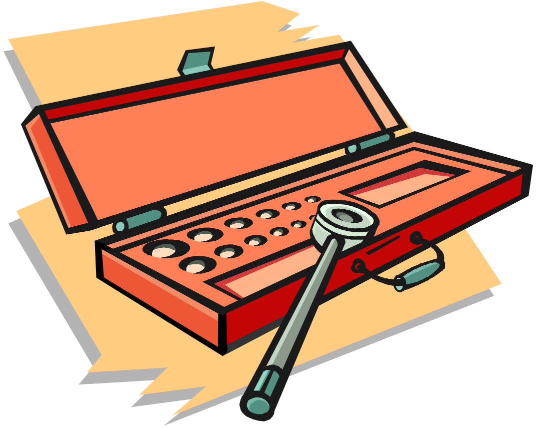
Same bi-directional one to many as last slide





Sets

- Sets are bags that can not contain duplicates:
  - A set still has no inherent order
  - A set can not contain duplicates
- Store bought toolboxes are generally a set
  - No duplicates
  - No inherent order*



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Mapping a Set

- java.util.Set maps as a Set

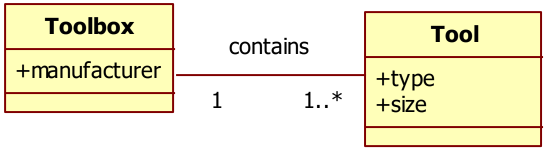
```
@Entity
public class Toolbox {
  @Id
  @GeneratedValue
  private int id;
  private String manufacturer;
  private String model;
  @OneToMany(mappedBy="toolbox", cascade=CascadeType.PERSIST)
  private Set<Tool> tools = new HashSet<Tool>();
```

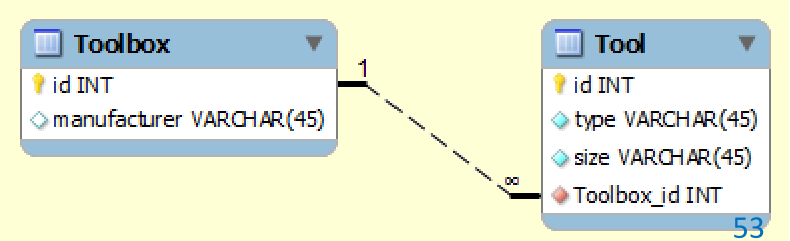
Set maps as a set

HashSet is the most common Set implementation

```
@Entity
public class Tool {
  @Id
  @GeneratedValue
  private int id;
  private String type;
  private String size;
  @ManyToOne
  private Toolbox toolbox;

  ...
```

Tool class completes the bi-directional many to one





Lists

- Lists have an inherent order:
  - A List has an inherent, arbitrary order
  - A List can still contain duplicates

- A shopping list is a typical list example
  - An inherent, although often arbitrary order
  - May contain duplicates

One to Many bi-directional List

```
@Entity
public class Person {
  @Id
  @GeneratedValue
  private int id;
  private String firstname;
  private String lastname;
  @OneToMany(cascade=CascadeType.PERSIST)
  @JoinColumn(name="buyer_id")
  @OrderColumn(name="sequence")
  private List<Item> shopList = new ArrayList<Item>();

  ...
```

```
@Entity
public class Item {
  @Id
  @GeneratedValue
  private int id;
  private String name;
  private String description;

  ...
```

@OrderBy

```
@Entity
public class Person {
   @Id
   @GeneratedValue
   private int id;
   private String firstname;
   private String lastname;
   @OneToMany(mappedBy="owner", cascade=CascadeType.PERSIST)
   @OrderBy(clause="type ASC")
   private List<Tool> tools = new ArrayList<Tool>();

   ...
```

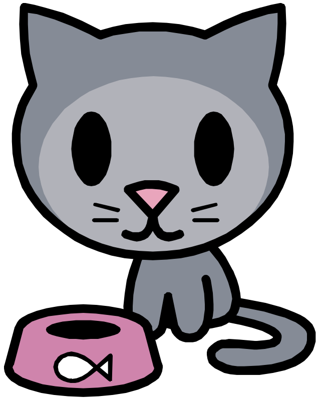
```
@Entity
public class Tool {
   @Id
   @GeneratedValue
   private int id;
   private String type;
   private String size;
   @ManyToOne
   private Person owner;

   ...
```

Order the list of Tools by the attribute ‘type’

Maps

- A Map ‘maps’ a set of keys to a bag of values:
  - Each value in the bag has a unique key
  - Given a key, the map can quickly retrieve the value
  - No inherent order in either keys or values

- Pet owner ship can be modeled as a map.
  - Each pet has a unique name*
  - To find a pet, you use its name
  - No inherent order in names or pets



Map

```
@Entity
public class Person {
   @Id
   @GeneratedValue
   private int id;
   private String firstname;
   private String lastname;
   @OneToMany(mappedBy="owner", cascade=CascadeType.PERSIST)
   @MapKey(name="name")
   private Map<String, Pet> pets = new HashMap<String, Pet>();

   ...
```

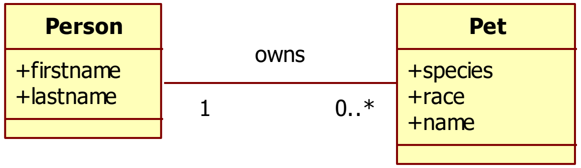
@MapKey specifies the key column on the remote class

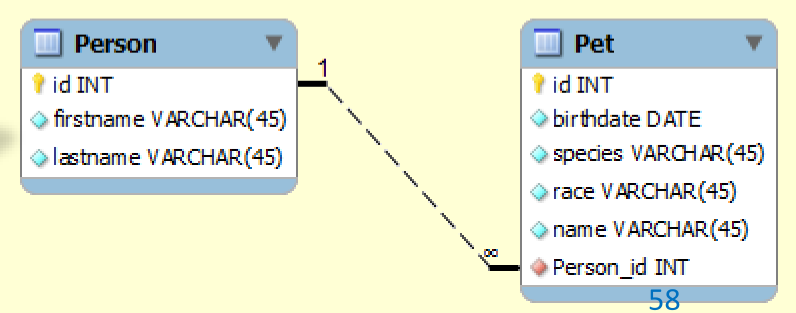
Normal @OneToMany

```
@Entity
public class Pet {
   @Id
   @GeneratedValue
   private int id;
   private String name;
   private String species;
   private String race;
   @ManyToOne
   private Person owner;
   ...
```

Specified by @MapKey, will be indexed

Normal @ManyToOne





Main point

- When an ordered list is stored in the database and you want to persist the order of the elements, then you need to save the order in the database.

Science of Consciousness: There is order in creation. Everything in creation works according the laws of nature.

Connecting the parts of knowledge with the wholeness of knowledge

1. Using JPA requires that the OO domain model looks very similar as the Relational database model.
2. Collections can be mapped as a Set, a Map, an unordered List and an ordered List

3. **Transcendental consciousness** is the most abstract field at the basis of all creation, with the greatest flexibility and power.
4. **Wholeness moving within itself:** In Unity Consciousness, we see that all layers of creation, from completely abstract to completely relative are nothing but the Self.