ORM and JPA 2.0

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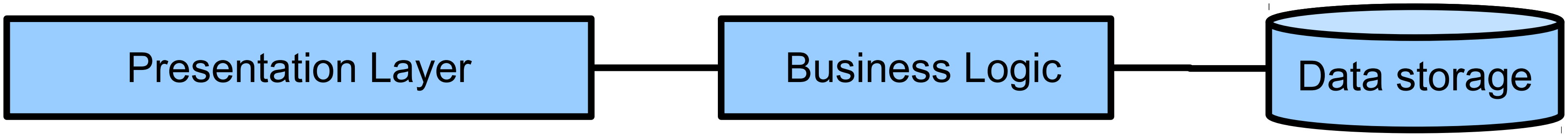
What is Object-relational mapping ?

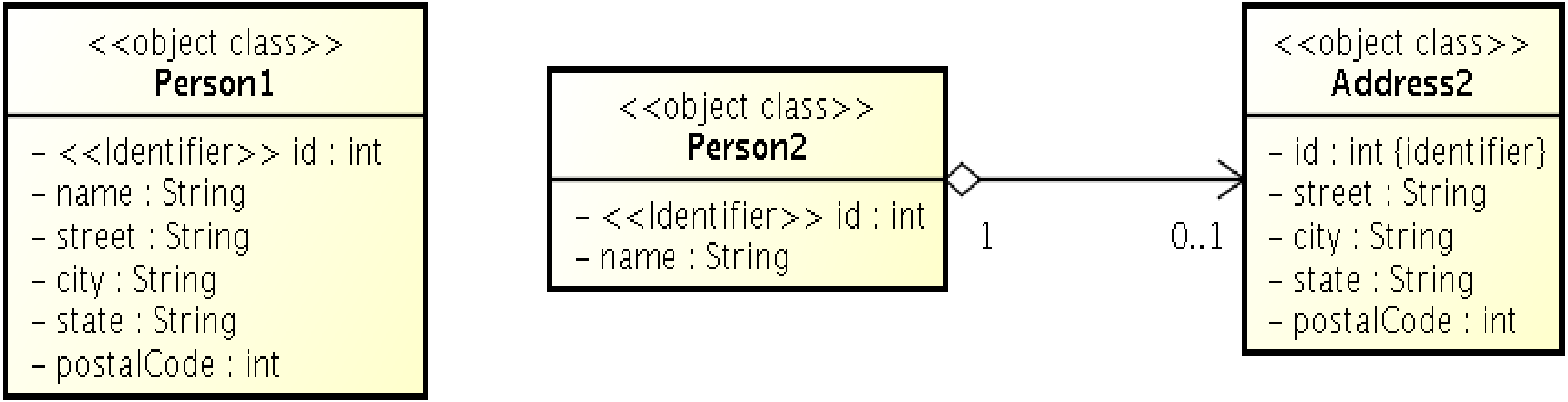
- a typical information system architecture:



- How to avoid data format transformations when interchanging data from the (OO-based) presentation layer to the data storage (RDBMS) and back ?
- How to ensure persistence in the (OO-based) business logic ?

Example – object model

- When would You stick to one of these options ?



<<object class>>
Person1

- <<Identifier>> id : int
- name : String
- street : String
- city : String
- state : String
- postalCode : int

<<object class>>
Person2

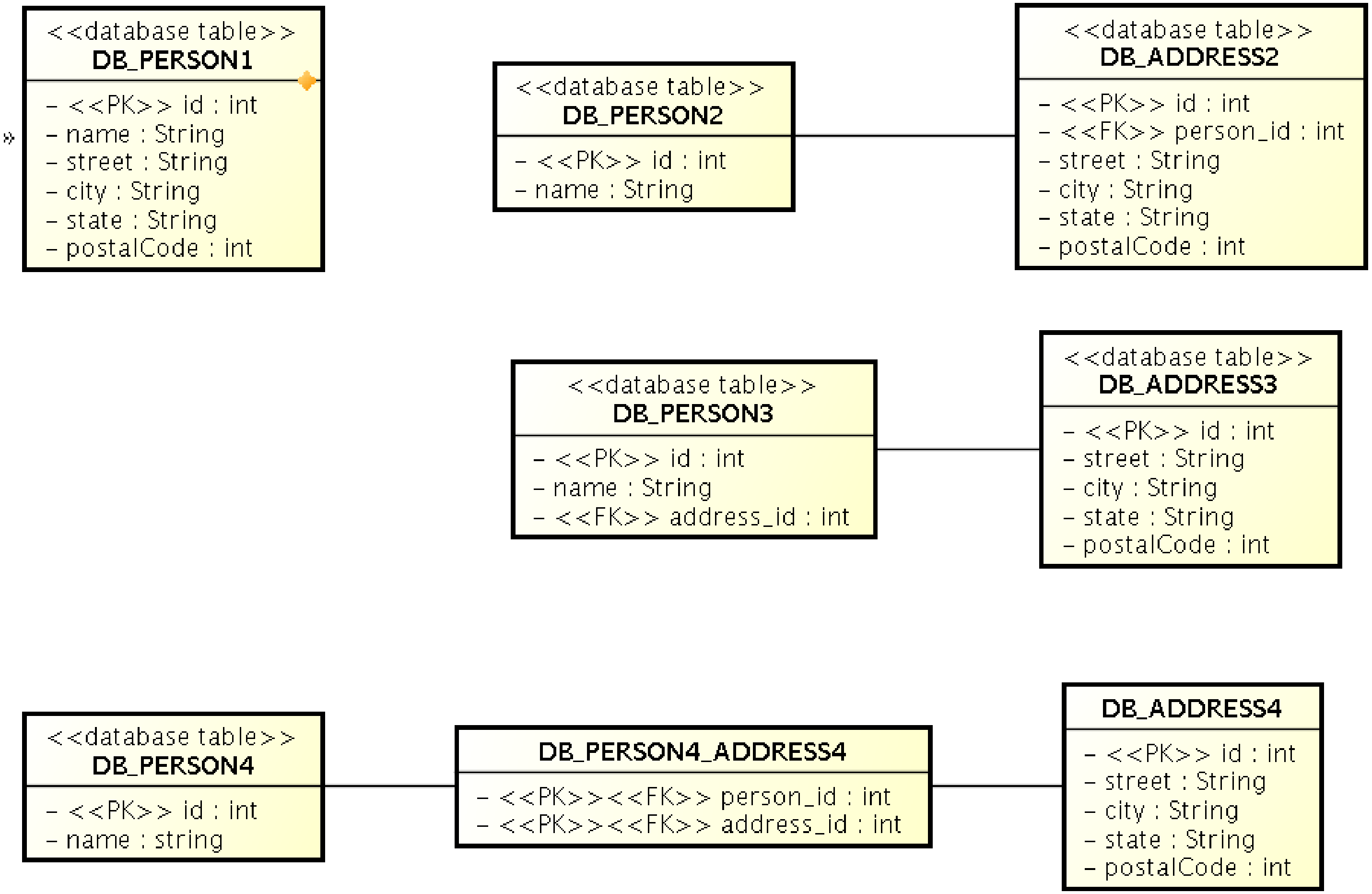
- <<Identifier>> id : int
- name : String

<<object class>>
Address2

- id : int {identifier}
- street : String
- city : String
- state : String
- postalCode : int

Example – database

- … and how to model it in SQL ?



<<database table>>
DB_PERSON1
- <<PK>> id : int
- name : String
- street : String
- city : String
- state : String
- postalCode : int

<<database table>>
DB_PERSON2
- <<PK>> id : int
- name : String

<<database table>>
DB_ADDRESS2
- <<PK>> id : int
- <<FK>> person_id : int
- street : String
- city : String
- state : String
- postalCode : int

<<database table>>
DB_PERSON3
- <<PK>> id : int
- name : String
- <<FK>> address_id : int

<<database table>>
DB_ADDRESS3
- <<PK>> id : int
- street : String
- city : String
- state : String
- postalCode : int

<<database table>>
DB_PERSON4
- <<PK>> id : int
- name : string

DB_PERSON4_ADDRESS4
- <<PK>><<FK>> person_id : int
- <<PK>><<FK>> address_id : int

DB_ADDRESS4
- <<PK>> id : int
- street : String
- city : String
- state : String
- postalCode : int

Object-relational mapping

- Mapping between the database (declarative) schema and the data structures in the object-oriented language.
- Let's take a look at JPA 2.0

Object-relational mapping

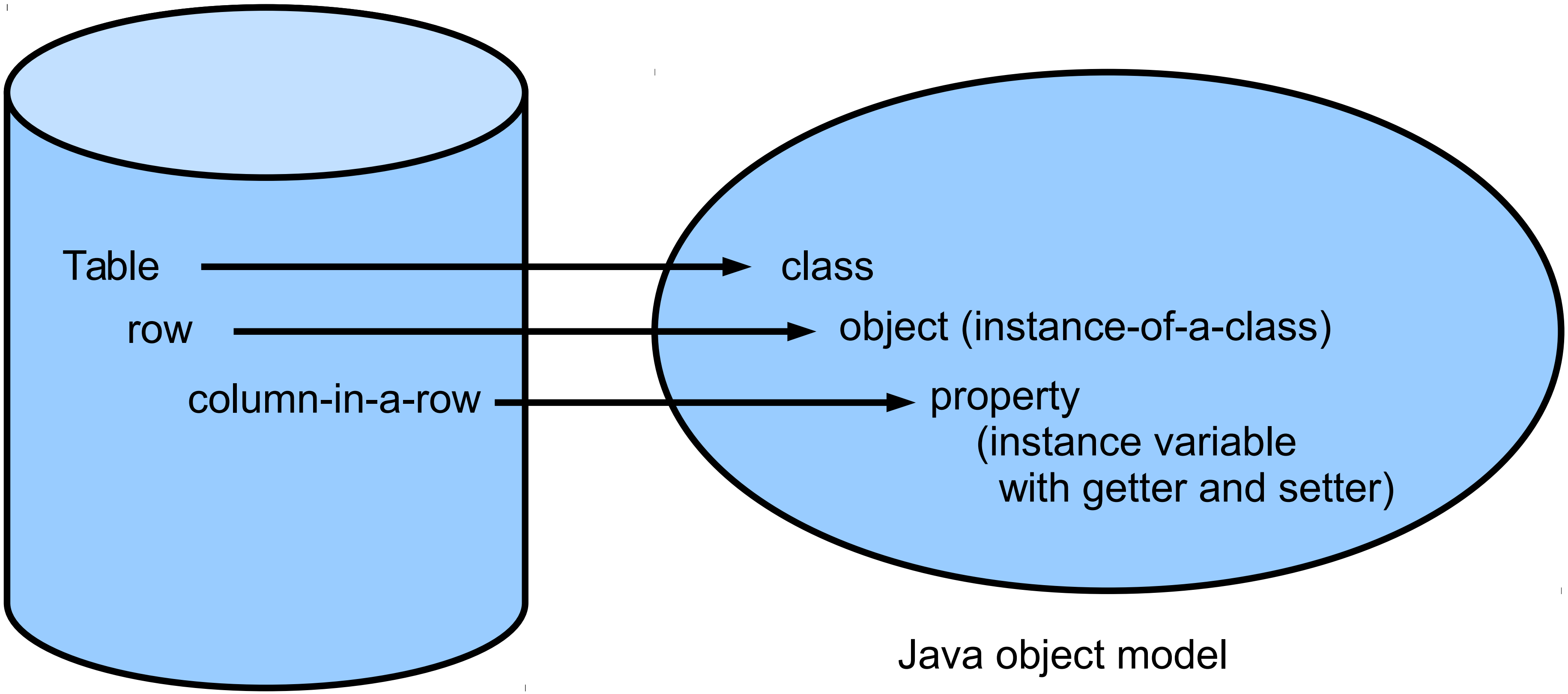


Table → class

row → object (instance-of-a-class)

column-in-a-row → property
(instance variable
with getter and setter)

Java object model

Relational database

JPA 2.0

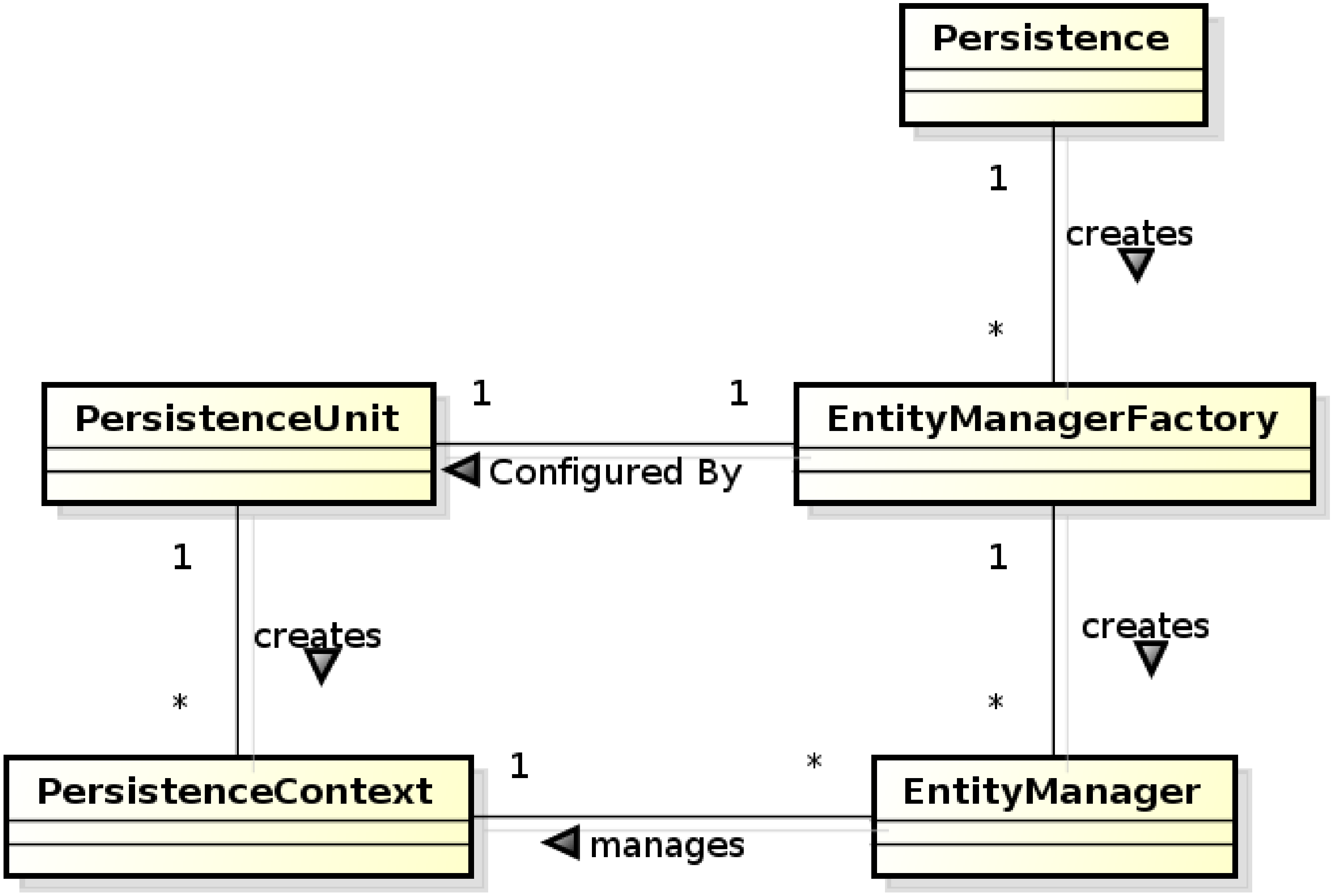
- Java Persistence API 2.0 (JSR-317)
- Although part of Java EE 6 specifications, JPA 2.0 can be used both in EE and SE applications.
- Main topics covered:
  - Basic scenarios
  - Controller logic – `EntityManager` interface
  - ORM strategies
  - JPQL + Criteria API

JPA 2.0 – Entity Example

- Minimal example (configuration by exception):

```
@Entity
public class Person {
    @Id
    @GeneratedValue
    private Integer id;
    private String name;
    // setters + getters
}
```

JPA2.0 – Basic concepts

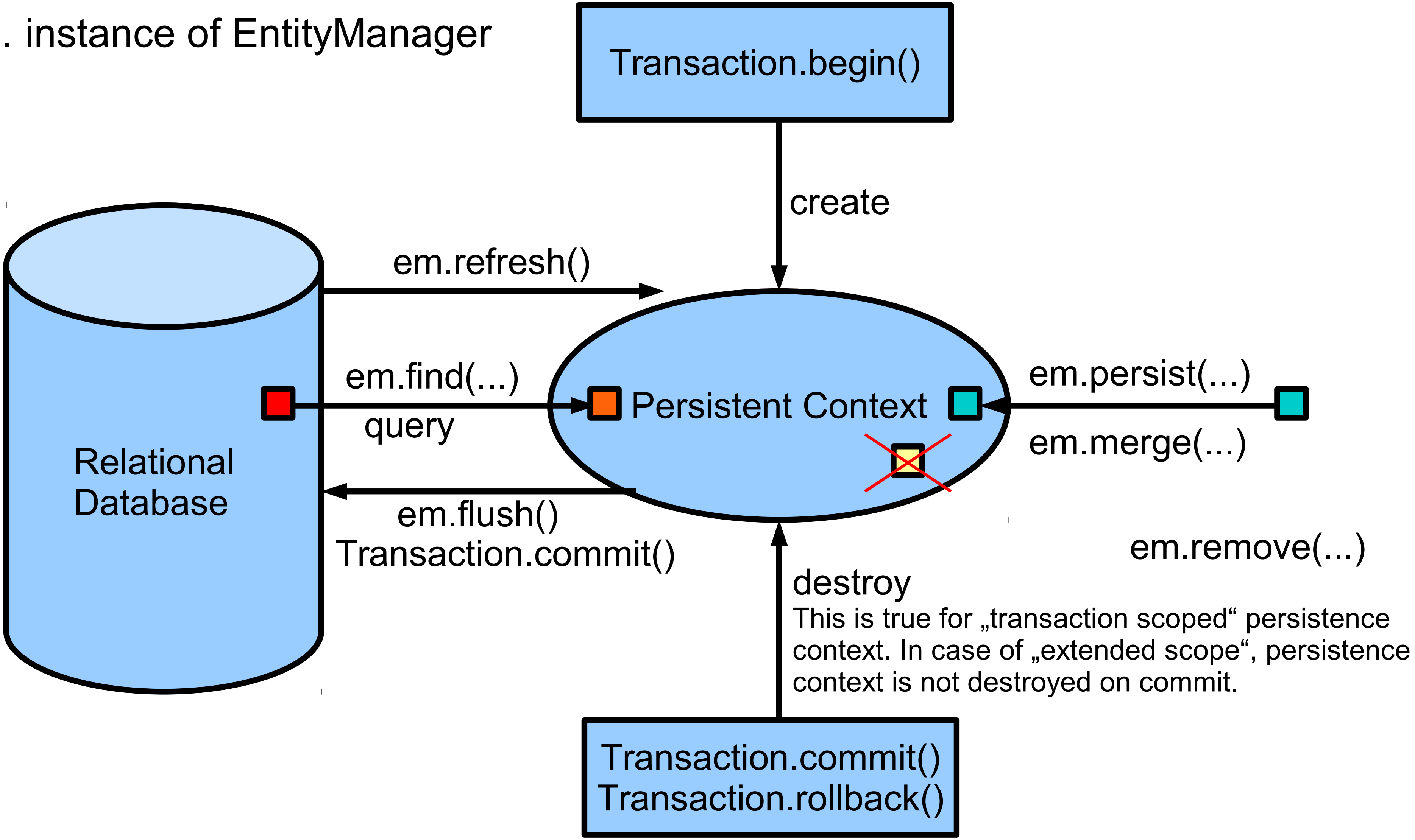


JPA 2.0 - Basics

- Let's have a set of „suitably annotated“ POJOs, called ***entities***, describing your domain model.
- A set of entities is logically grouped into a ***persistence unit***.
- JPA 2.0 providers :
  - generate persistence unit from existing database,
  - generate database schema from existing persistence unit.
  - TopLink (Oracle) … JPA
  - EclipseLink (Eclipse) … JPA 2.0
- What is the benefit of the keeping Your domain model in the persistence unit entities (OO) instead of the database schema (SQL)

JPA 2.0 – Persistence Context

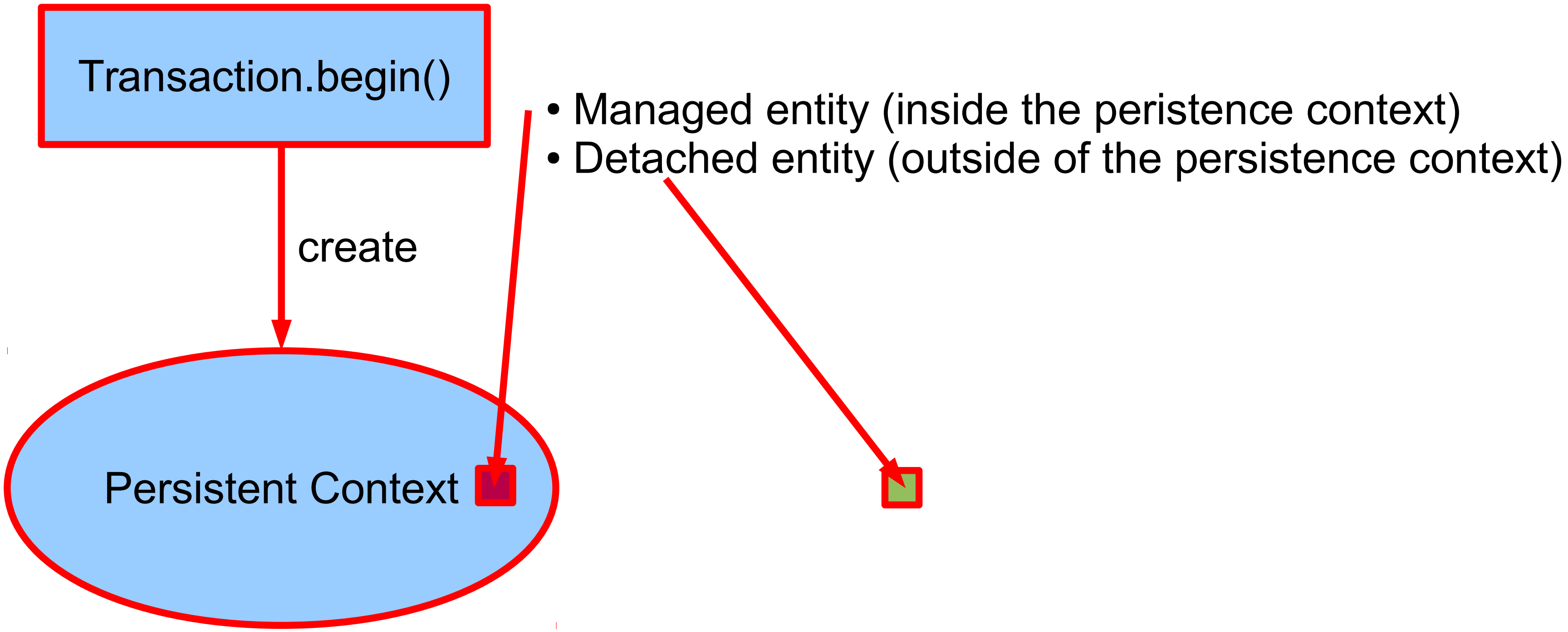
em … instance of EntityManager



This is true for „transaction scoped“ persistence context. In case of „extended scope“, persistence context is not destroyed on commit.

JPA 2.0 – Persistence Context

em … instance of EntityManager



- Managed entity (inside the peristence context)
- Detached entity (outside of the persistence context)

- em.persist(entity) … persistence context must not contain an entity with the same id
- em.merge(entity) … merging the state of an entity existing inside the persistence context and its other incarnation outside

JPA 2.0 – Persistence Context

- In runtime, the application accesses the object counterpart (represented by entity instances) of the database data. These (*managed*) entities comprise a ***persistence context (PC)***.
  - PC is synchronized with the database on demand (refresh, flush) or at transaction commit.
  - PC is accessed by an `EntityManager` instance and can be shared by several `EntityManager` instances.

JPA 2.0 – EntityManager

- **`EntityManager` (EM)** instance is in fact a generic DAO, while entities can be understand as DPO (managed) or DTO (detached).
- Selected operations on EM (CRUD) :
  - ***C***reate : em.persist(Object o)
  - ***R***ead : em.find(Object id), em.refresh(Object o)
  - ***U***pdate : em.merge(Object o)
  - ***D***elete : em.remove(Object o)
  - native/JPQL queries: createNativeQuery, createQuery, etc.
  - Resource-local transactions: getTransaction().[begin(),commit(),rollback()]

ORM - Basics

- Simple View
  - Object classes = entities = SQL tables
  - Object properties (fields/accessor methods) = entity properties = SQL columns
- The ORM is realized by means of Java annotations/XML.
- Physical Schema annotations
  - @Table, @Column, @JoinColumn, @JoinTable, etc.
- Logical Schema annotations
  - @Entity, @OneToMany, @ManyToMany, etc.
- Each property can be fetched lazily/eagerly.

Access types – Field access

```
@Entity
public class Employee {
   @Id
   private int id;
   …
   public int getId() {return id;}
   public void set Id(int id) {this.id=id;}
   …
}
```

The provider will get and set the fields of the entity using reflection (not using getters and setters).

Access types – Property access

```
@Entity
public class Employee {
   private int id;
   …
   @Id
   public int getId() {return id;}
   public void setId(int id) {this.id=id;}
   …
}
```

Annotation is placed in front of getter.
(Annotation in front of setter omitted)

The provider will get and set the fields of the entity by invoking getters and setters.

Access types – Mixed access

- Field access with property access combined within the same entity hierarchy (or even within the same entity).

- @Access – defines the default access mode
  (may be overriden for the entity subclass)

- An example on the next slide

Access types – Mixed access

```
@Entity @Access(AccessType.FIELD)
public class Employee {
    public static final String LOCAL_AREA_CODE = “613“;
    @Id private int id;
    @Transient private String phoneNum;
    …
    public int getId() {return Id};
    public void setId(int id) {this.id = id;}

    public String getPhoneNumber() {return phoneNum;}
    public void setPhoneNumber(Strung num) {this.phoneNum=num;}

    @Access(AccessType.PROPERTY) @Column(name=“PHONE“)
    protected String getPhoneNumberForDb() {
        if (phoneNum.length()==10) return phoneNum;
        else return LOCAL_AREA_CODE + phoneNum;
    }
    protected void setPhoneNumberForDb(String num) {
        if (num.startsWith(LOCAL_AREA_CODE))
            phoneNum = num.substring(3);
        else phoneNum = num;
}
```

ORM – Basic data types

- Primitive Java types: String → varchar/text, Integer → int, Date → TimeStamp/Time/Date, etc.
- Wrapper classes, basic type arrays, Strings, temporal types
- @Column – physical schema properties of the particular column (nullable, insertable, updatable, precise data type, defaults, etc.)
- @Lob – large objects
- Default EAGER fetching (except Lobs)

ORM – Enums, dates

- `@Enumerated(value=EnumType.String)`

  `private EnumPersonType type;`

  - Stored either in text column, or in int column
- `@Temporal(TemporalType.Date)`

  `private java.util.Date datum;`

  - Stored in respective column type according to the TemporalType.

ORM – Identifiers

- Single-attribute: @Id,
- Multiple-attribute – an identifier class must exist
  - Id. class: @IdClass, entity ids: @Id
  - Id. class: @Embeddable, entity id: @EmbeddedId
- How to write `hashCode`, `equals` for entities ?
-
```
@Id
@GeneratedValue(strategy=GenerationType.SEQUENCE)
private int id;
```

Generated Identifiers

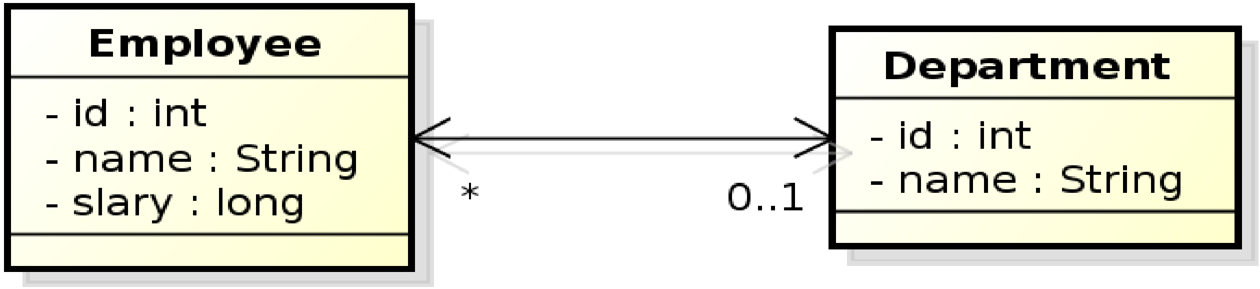
Strategies

- AUTO - the provider picks its own strategy
- TABLE – special table keeps the last generated values
- SEQUENCE – using the database native SEQUENCE functionality (PostgreSQL)
- IDENTITY – some DBMSs implement autonumber column

Generated Identifiers
TABLE strategy

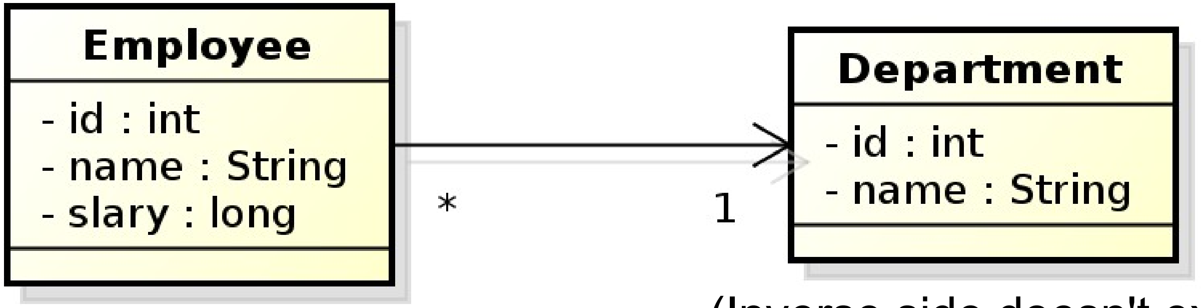
```
@TableGenerator(
   name=“AddressGen“,
   table=“ID_GEN“,
   pkColumnName=“GEN_NAME“,
   valueColumnName=“GEN_VAL“,
   pkColumnValue=“ADDR_ID“,
   initialValue=10000,
   allocationSize=100)

@Id @GeneratedValue(generator=“AddressGen“)

private int id;
```

ORM – Relationships



Owning side

Inverse side



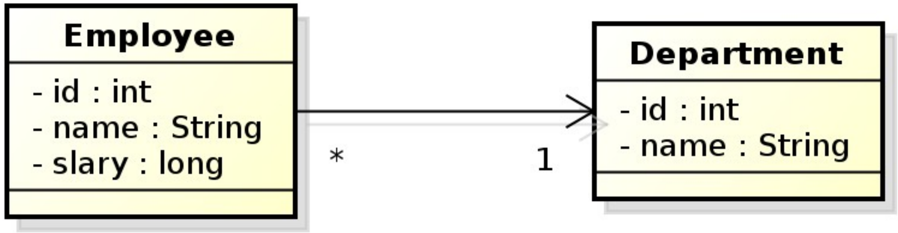
Owning side

(Inverse side doesn't exist)

ORM – Relationships

		unidirectional	bidirectional
many-to-one	owning	@ManyToOne [@JoinColumn]	@ManyToOne [@JoinColumn]
	inverse	X	@OneToMany(mappedBy)
one-to-many	owning	@OneToMany [@JoinTable]	@OneToMany [@JoinColumn]
	inverse	X	@ManyToOne(mappedBy)
one-to-one	owning (any)	@OneToOne [@JoinColumn]	@OneToOne [@JoinColumn]
	inverse (the other)	X	@OneToOne(mappedBy)
many-to-many	owning (any)	@ManyToMany [@JoinTable]	@ManyToMany [@JoinTable]
	inverse (the other)	X	@ManyToMany(mappedBy)

Unidirectional many-to-one relationship

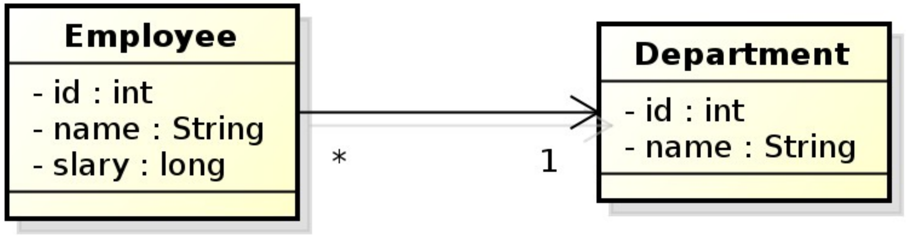


Owning side

```
@Entity
public class Employee {
   // …
   @ManyToOne
   private Department department;
   // …
}
```

In database, the N:1 relationship is implemented as a foreign key placed in the Employee table. In this case, the foreign key has a default name.

Unidirectional many-to-one relationship

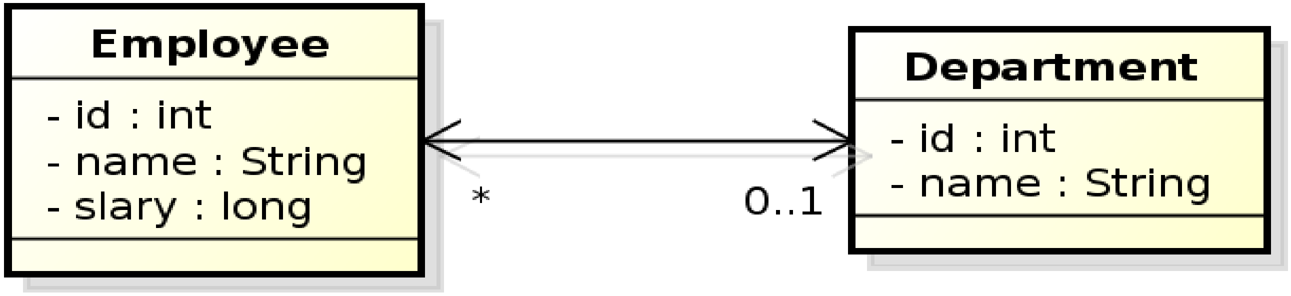


Owning side

```
@Entity
public class Employee {

   @Id private int id;
   Private String name;
   @ManyToOne
   @JoinColumn(name=“DEPT_ID“)
   private Department department;

}
```

In this case, the foreign key is defined as the @JoinColumn annotation.

Bidirectional many-to-one relationship



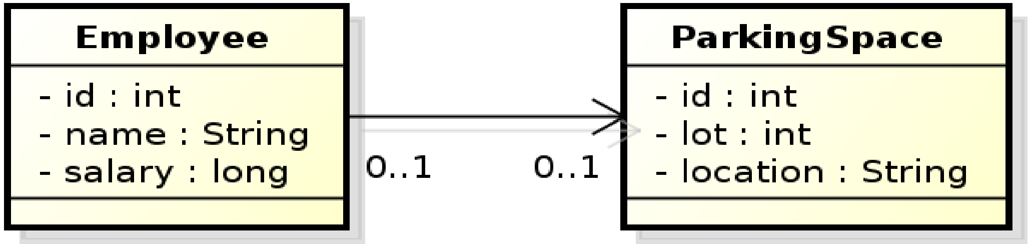
Owning side

Inverse side

```
@Entity
public class Employee {

    @Id private int id;
    private String name;
    @ManyToOne
    @JoinColumn(name=“DEPT_ID“)
    private Department department;

}
```

```
@Entity
public class Department {

    @Id private int id;
    private String name;
    @OneToMany(mappedBy=“department“)
    private Collection<Employee> employees;
}
```

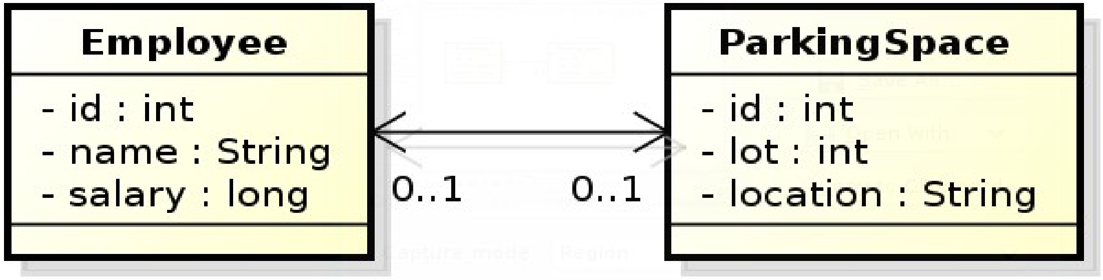
Unidirectional one-to-one relationship



Owning side

```
@Entity
public class Employee {

   @Id private int id;
   private String Name;
   @OneToOne
   @JoinColumn(name=“PSPACE_ID“)
   private ParkingSpace parkingSpace;

}
```

Bidirectional one-to-one relationship



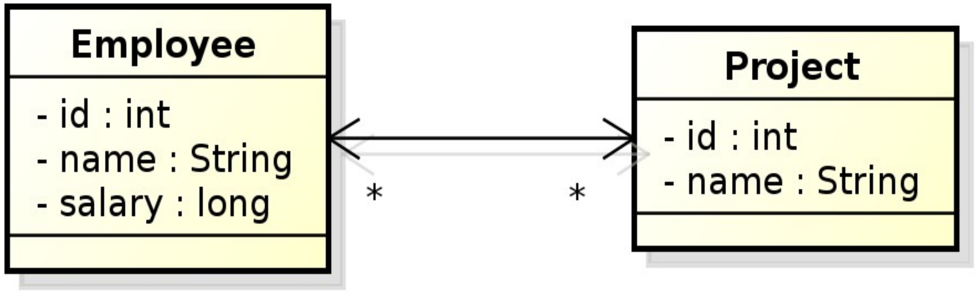
Owning side

Inverse side

```
@Entity
public class Employee {

    @Id private int id;
    private String Name;
    @OneToOne
    @JoinColumn(name="PSPACE_ID")
    private ParkingSpace parkingSpace;

}
```

```
@Entity
public class ParkingSpace {

    @Id private int id;
    private int lot;
    private String location;
    @OneToOne(mappedBy="parkingSpace");
      private Employee employee;

}
```

Bidirectional many-to-many relationship



Owning side

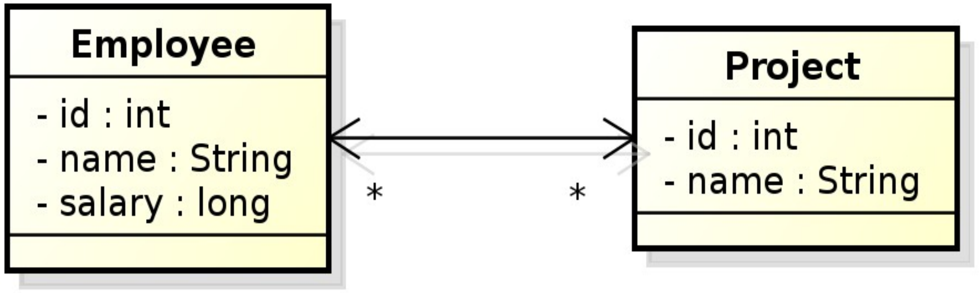
Inverse side

```
@Entity
public class Employee {

  @Id private int id;
  private String Name;
  @ManyToMany
  private Collection<Project> projects;

}
```

```
@Entity
public class Project {

   @Id private int id;
   private String name;
   @ManyToMany(mappedBy=“projects“);
   private Collection<Employee> employees;

}
```

In database, N:M relationship must be implemented by means of a table with two foreign keys. In this case, both the table and its columns have default names.

Bidirectional many-to-many relationship



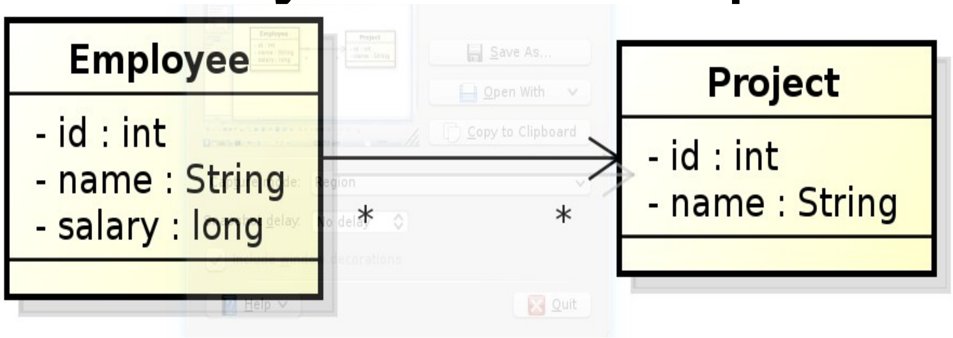
Owning side

Inverse side

```
@Entity
public class Employee {

    @Id private int id;
    private String Name;
    @ManyToMany
    @JoinTable(name=“EMP_PROJ“,
        joinColumns=@JoinColumn(name=“EMP_ID“),
        inverseJoinColumns=@JoinColumn(name=“PROJ_ID“))
    private Collection<Project> project;

}
```

```
@Entity
public class Project {

    @Id private int id;
    private String name;
    @ManyToMany(mappedBy=“projects“);
    private Collection<Employee> employees;

}
```

Unidirectional many-to-many relationship



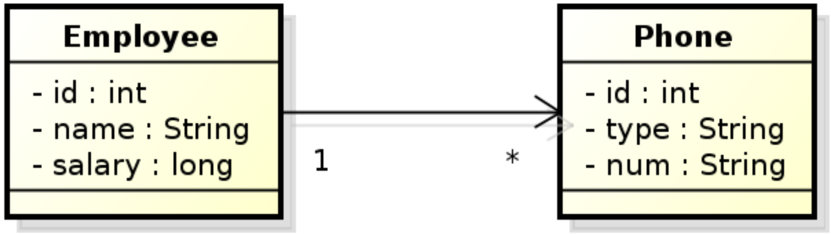
Owning side

```
@Entity
public class Employee {

    @Id private int id;
    private String Name;
    @ManyToMany
    @JoinTable(name=“EMP_PROJ“,
        joinColumns=@JoinColumn(name=“EMP_ID“),
        inverseJoinColumns=@JoinColumn(name=“PROJ_ID“))
    private Collection<Project> project;

}
```

```
@Entity
public class Project {

   @Id private int id;
   private String name;

}
```

Unidirectional one-to-many relationship

JPA 2.0 spec: *The **default** mapping for unidirectional one-to-many relationships uses a **join table**. Unidirectional one-to-many relationship **may be** implemented using **one-to many foreign key mappings**, using the JoinColumn and JoinColumns annotations.*

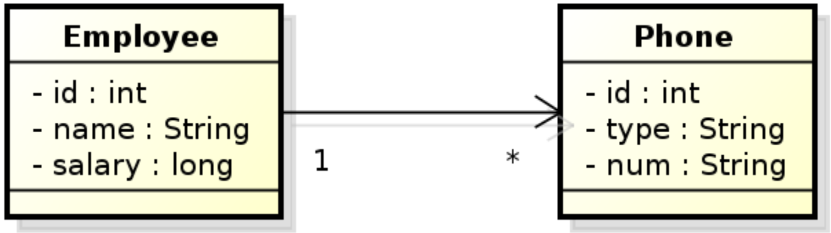


Owning side

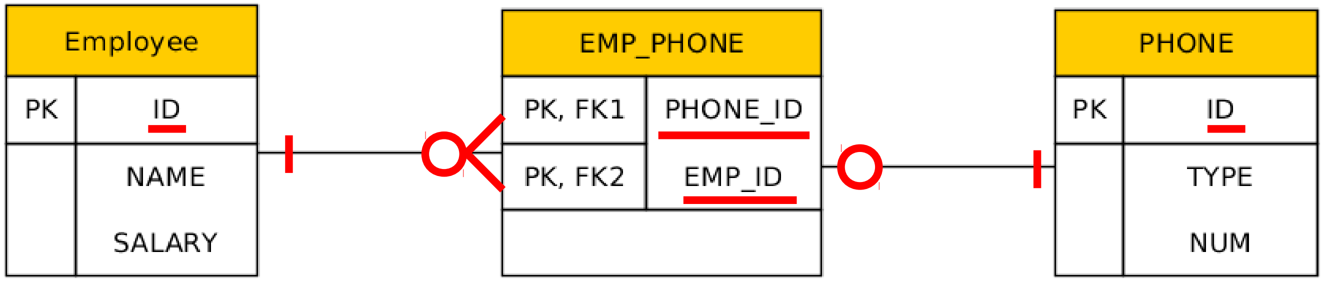
```
@Entity
public class Employee {

    @Id private int id;
    private String name;
    private float salary;
    @OneToMany
    @JoinColumn(name=“EMP_ID“)           // join column is in the table for Phone
    private Collection<Phone> phones;

}
```

Not available prior to JPA 2.0

Unidirectional one-to-many relationship



Owning side



Employee	
PK	ID
	NAME SALARY

EMP_PHONE	
PK, FK1	PHONE_ID
PK, FK2	EMP_ID

PHONE	
PK	ID
	TYPE NUM

Logical database schema

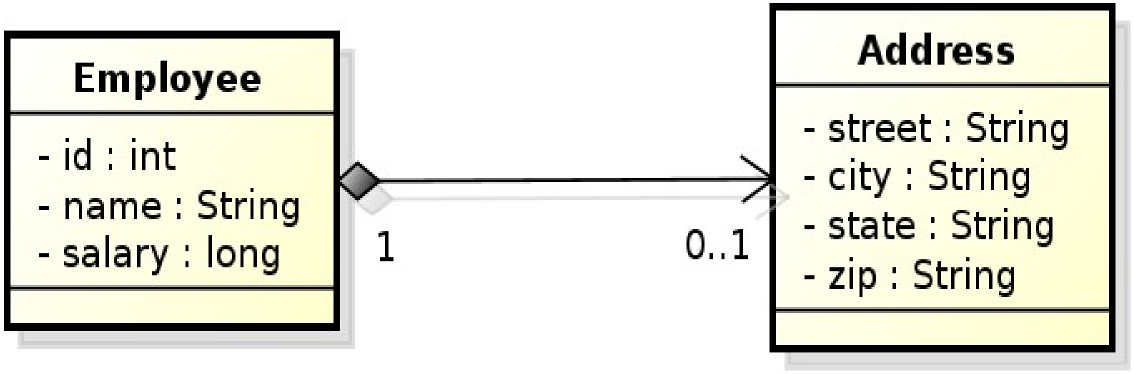
```
@Entity
public class Employee {

    @Id private int id;
    private String name;
    private float salary;
    @OneToMany
    @JoinTable(name=“EMP_PHONE“,
        joinColumns=@JoinColumn(name=“EMP_ID“),
        inverseJoinColumns=@JoinColumn(name=“PHONE_ID“))
    private Collection<Phone> phones;

}
```

Lazy Relationships

```
@Entity
public class Employee {

   @Id private int id;
   private String name;
   @OneToOne(fetch=FetchType.LAZY)
   private ParkingSpace parkingSpace;

}
```

Embedded Objects

EMPLOYEE	
PK	ID
	NAME SALARY STREET CITY STATE ZIP_CODE



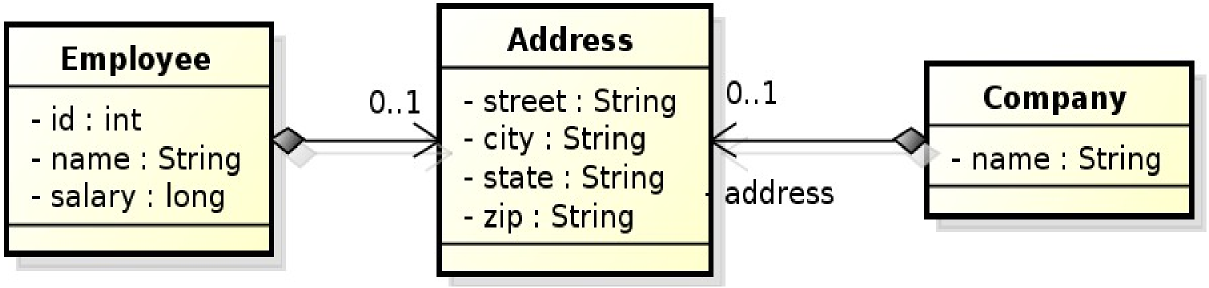
```
@Embeddable
@Access(AccessType.FIELD)
public class Address {
   private String street;
   private String city;
   private String state;
   @Column(name=“ZIP_CODE“)
   private String zip;
}
```

```
@Entity
public class Employee {
   @Id private int id;
   private String name;
   private long salary;
   @Embedded private Address
address;
}
```

Embedded Objects

EMPLOYEE	
PK	ID
	NAME SALARY STREET CITY PROVINCE POSTAL_CODE

COMPANY	
PK	NAME
	STREET CITY STATE ZIP_CODE

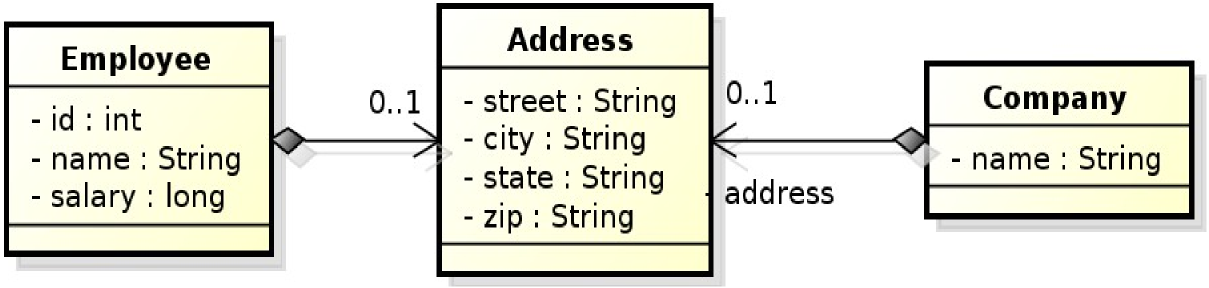


```
@Embeddable
@Access(AccessType.FIELD)
public class Address {
   private String street;
   private String city;
   private String state;
   @Column(name=“ZIP_CODE“)
   private String zip;
}
```

Embedded Objects

EMPLOYEE	
PK	ID
	NAME SALARY STREET CITY PROVINCE POSTAL_CODE

COMPANY	
PK	NAME
	STREET CITY STATE ZIP_CODE



Employee
- id : int
- name : String
- salary : long

Address
- street : String
- city : String
- state : String
- zip : String

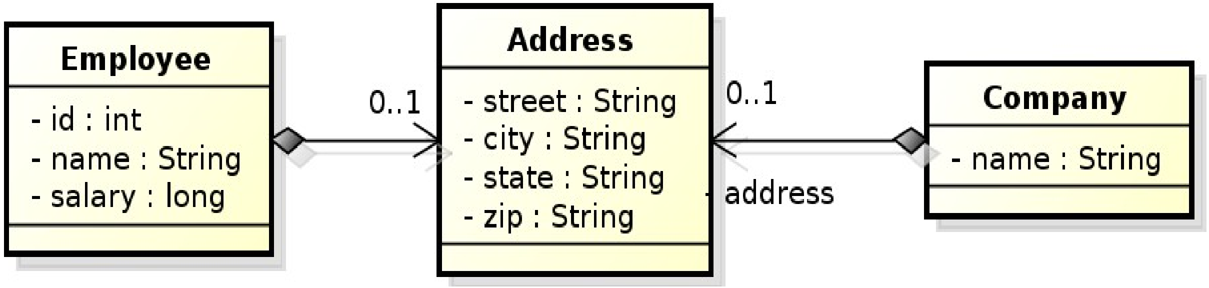
Company
- name : String

```
@Entity
public class Company {
   @Id private String name;
   @Embedded
   private Address address;
}
```

Embedded Objects

EMPLOYEE	
PK	ID
	NAME
	SALARY
	STREET
	CITY
	PROVINCE
	POSTAL_CODE

COMPANY	
PK	NAME
	STREET
	CITY
	STATE
	ZIP_CODE

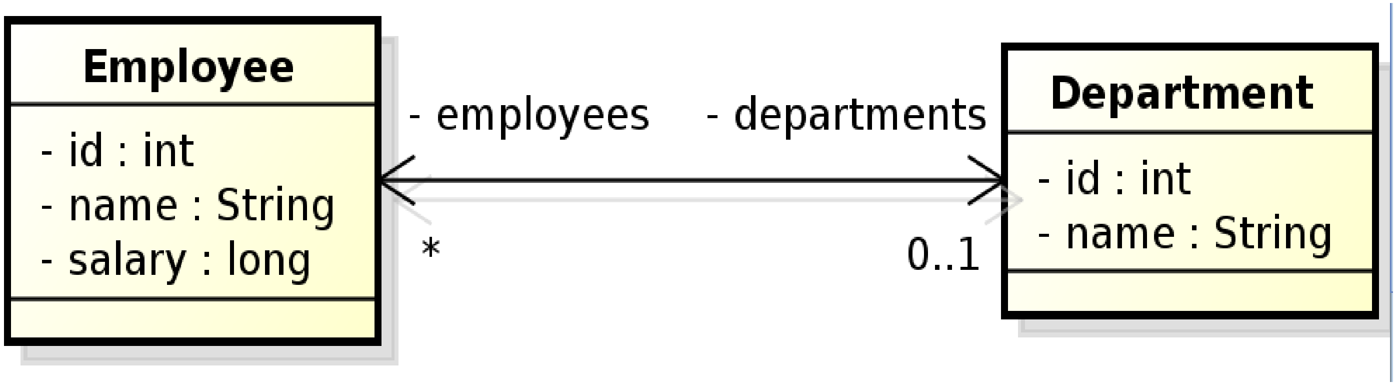


```
@Entity
public class Employee {
    @Id private int id;
    private String name;
    private long salary;
    @Embedded
    @AttributeOverrides({
        @AttributeOverride(name=“state“, column=@Column(name=“PROVINCE“)),
        @AttributeOverride(name=“zip“, column=@Column(name=“POSTAL_CODE“))
    })
    private Address address;
}
```

Cascade Persist

```
@Entity
public class Employee {
    // …
    @ManyToOne(cascade=cascadeType.PERSIST)
    Address address;
    // …
}


Employee emp = new Employee();
emp.setId(2);
emp.setName(“Rob“);
Address addr = new Address();
addr.setStreet(“164 Brown Deer Road“);
addr.steCity(“Milwaukee“);
addr.setState(“WI“);
emp.setAddress(addr);
~~emp.persist(addr);~~
emp.persist(emp);
```

Persisting bidirectional relationship



```
…
Employee emp = new Employee();
emp.setId(2);
emp.setName(“Rob“);
emp.setSalary(25000);
Department dept = em.find(Deprtment.class, 101);
dept.employees.add(emp);  // @ManyToOne(cascade=cascadeType.PERSIST)
emp.persist(emp);
```

!!! emp.departments still doesn't contain dept !!!

```
emp.refresh(dept);
```

!!! emp.departments does contain dept now !!!

Cascade

List of operations supporting cascading:

- cascadeType.ALL
- cascadeType.DETACH
- cascadeType.MERGE
- cascadeType.PERSIST
- cascadeType.REFRESH
- cascadeType.REMOVE