Inheritance

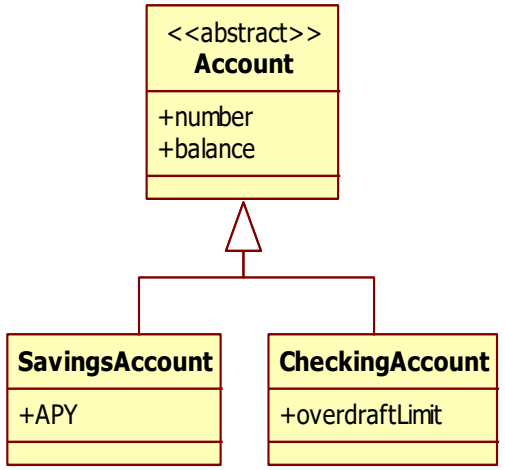
HIBERNATE

Inheritance

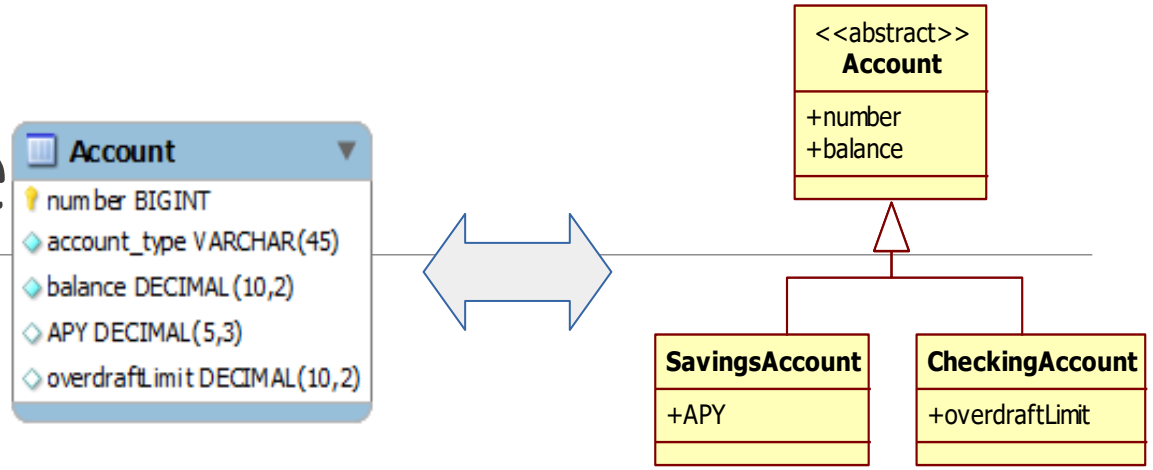
- With Inheritance a class can extend another class
  - Inheriting its properties and methods
  - Often referred to as an 'IS-A' relationship

- Relational **does not have** inheritance
  - There are 3 ways to emulate it

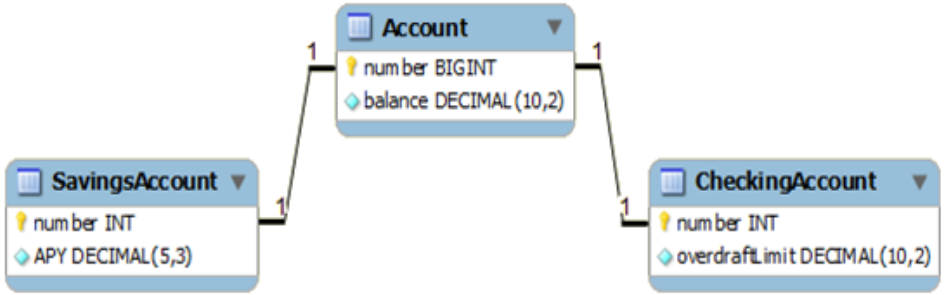
In our example Account is abstract



Emulate Inheritance



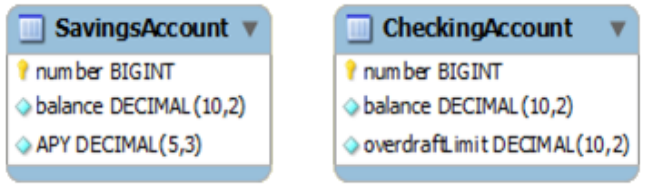
- **Single Table** per Hierarchy
  - De-normalized schema
  - Fast DB operations



- **Joined** Tables
  - Normalized schema
  - Bit slower operations

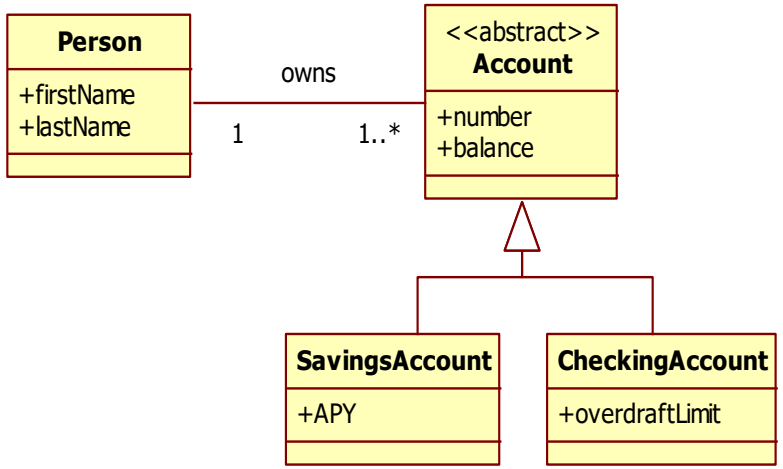
- **Table per** Concrete Class
  - Uses UNION instead of JOIN
  - All needed columns in each

JPA does not require implementers to provide this strategy



Polymorphism

- Polymorphism is the ability of a **subtype** to appear and behave **like its super type**
- This enables a person to have a list of account references, which can be any type of account
- A polymorphic query is a query for all objects in a hierarchy, independent of subtype

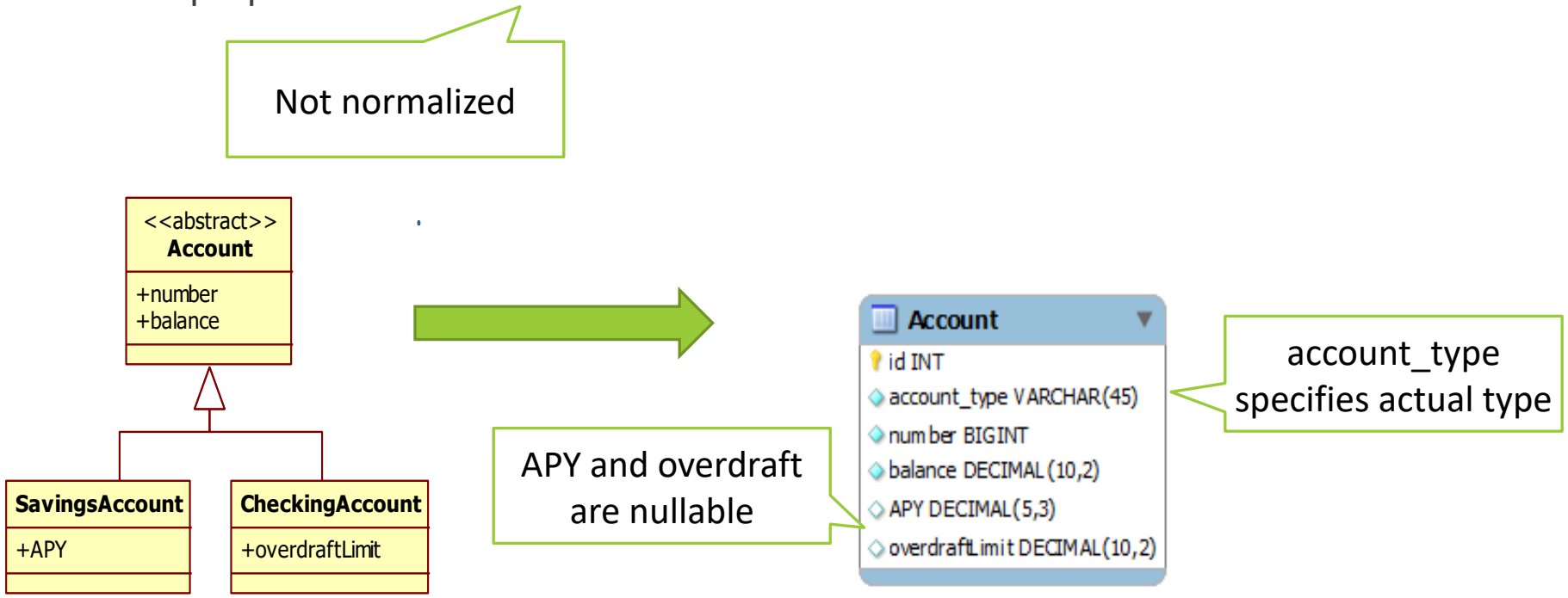


Inheritance: Single Table

HIBERNATE

Single Table

- Single Table uses **one big table**
  - **Discriminator column** specifies actual type
  - Sub class properties added as nullable columns



Single Table Mapping

Optional @Inheritance
Optional strategy
Default = SINGLE_TABLE

```
@Entity
@Inheritance(strategy=InheritanceType.SINGLE_TABLE)
@DiscriminatorColumn(name="account_type",
        discriminatorType=DiscriminatorType.STRING)
public abstract class Account {
        @Id
        @GeneratedValue(strategy = GenerationType.IDENTITY)
        private Integer id;
        private Long number;
        private double balance;
```

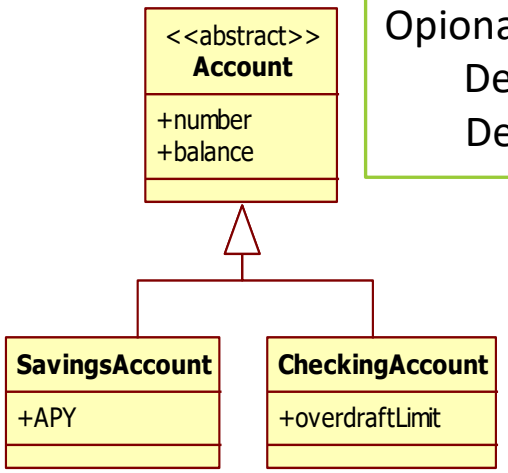
Opional @DiscriminatorColumn
Default name is: DTYPE
Default type is: STRING

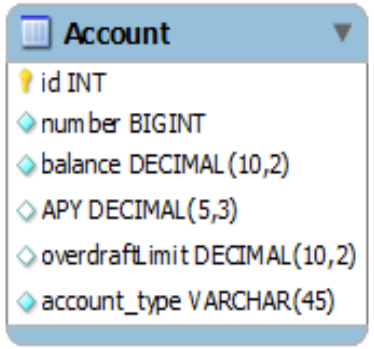
Opional @DiscriminatorValue
Default value is class name

```
@Entity
@DiscriminatorValue("savings")
public class SavingsAccount extends Account {
        private double APY;
```

```
@Entity
@DiscriminatorValue("checking")
public class CheckingAccount extends Account {
        private double overdraftLimit;
```

Important: subclasses do not have an **@Id**





Single Table in Action

ACCOUNT_TYPE	NUMBER	BALANCE	OVERDRAFTLIMIT	APY
checking	1	500	200	
savings	2	100		2.3
checking	3	23.5	0	

APY null for checking
overdraft null for savings

- ✓ Simple, easy to implement
- ✓ Good performance on all queries (poly and not)

- × Nullable columns / de-normalized
- × Table may have to contain lots of columns

SQL for Single Table Query

```
select
        account0_.number as number0_,
        account0_.balance as balance0_,
        account0_.owner_id as owner6_0_,
        account0_.overdraftLimit as overdraf4_0_,
        account0_.APY as APY0_,
        account0_.account_type as account1_0_
from
        Account account0_
```

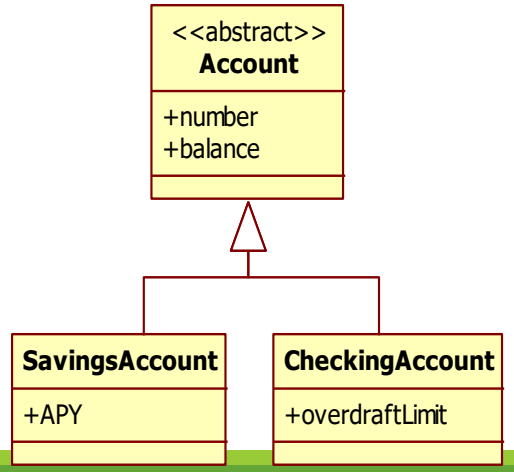
Defaults

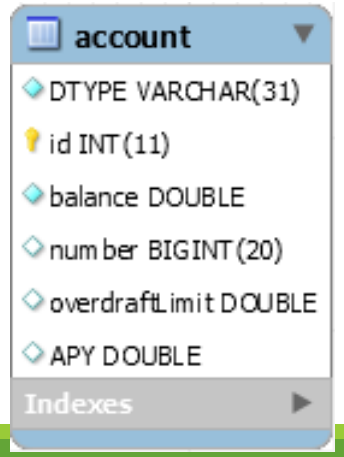
- Works without extra annotations
  - Defaults to Single Table

```
@Entity
public abstract class Account {
        @Id
        @GeneratedValue(strategy = GenerationType.IDENTITY)
      private Integer id;
      private Long number;
      private double balance;
```

```
@Entity
public class SavingsAccount extends Account {
        private double APY;
```

```
@Entity
public class CheckingAccount extends Account {
        private double overdraftLimit;
```



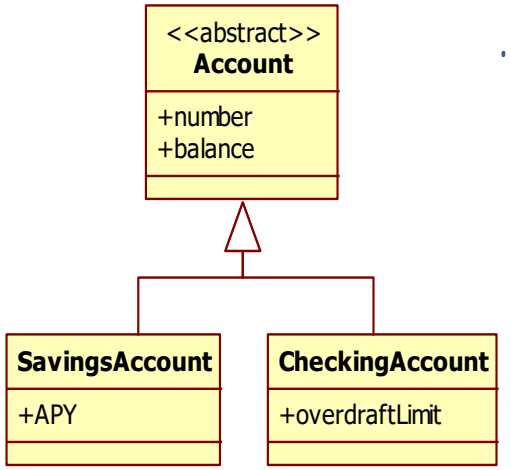


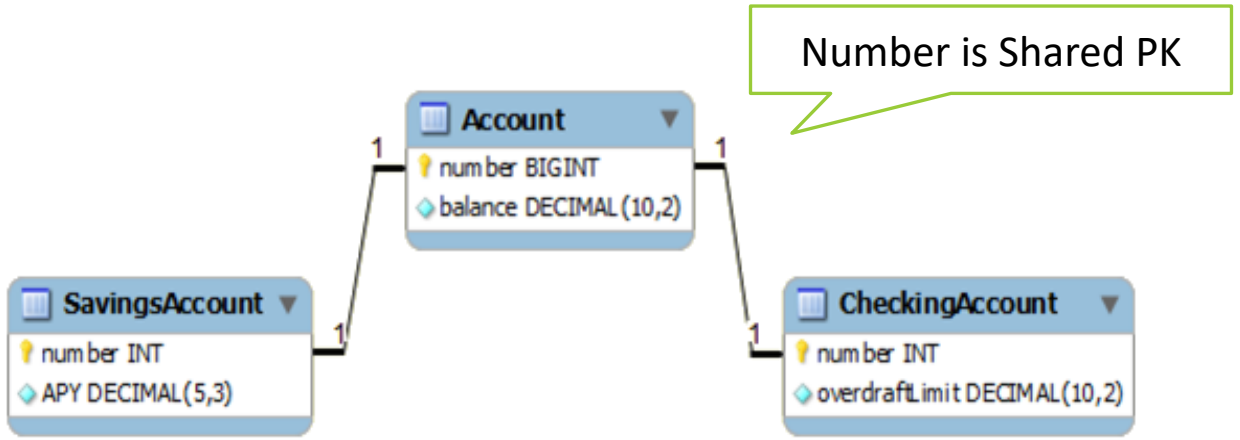
Inheritance: Joined Tables

HIBERNATE

Joined Tables

- Uses FK '**has-a**' to emulate '**is-a**'
  - Uses **Shared Primary Key** as Foreign Key
  - Queries use joins to include needed tables





Joined Mapping

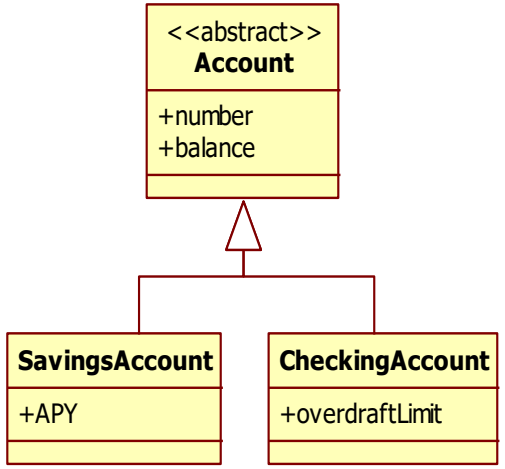
- Simply set the **strategy to JOINED**

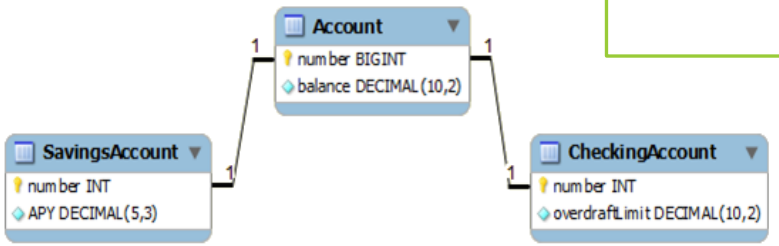
```
@Entity
@Inheritance(strategy=InheritanceType.JOINED)
public abstract class Account {
        @Id
        @GeneratedValue(strategy = GenerationType.IDENTITY)
        private Long number;
        private double balance;
```

```
@Entity
public class SavingsAccount extends Account {
        private double APY;
```

```
@Entity
public class CheckingAccount extends Account {
        private double overdraftLimit;
```

Remember: subclasses do not have an **@Id**





Joined Tables in Action

Account Table

NUMBER	BALANCE
1	500
2	100
3	23.5

SavingsAccount

NUMBER	APY
2	2.3

CheckingAccount

NUMBER	OVERDRAFTLIMIT
1	200
3	0

- ✓ Normalized Schema
- ✓ Database view similar to domain
- ✗ Inserting or updating takes multiple statements
- ✗ Joins make queries slower

SQL for Joined Query

```
select
        account0_.number as number0_,
        account0_.balance as balance0_,
        account0_.owner_id as owner3_0_,
        account0_1_.overdraftLimit as overdraf1_1_,
        account0_2_.APY as APY2_,
        case
            when account0_1_.number is not null then 1
            when account0_2_.number is not null then 2
            when account0_.number is not null then 0
        end as clazz_
    from
        Account account0_
    left outer join
        CheckingAccount account0_1_
            on account0_.number=account0_1_.number
    left outer join
        SavingsAccount account0_2_
            on account0_.number=account0_2_.number
```

Discriminator generated based on what is joined

Inheritance
Table Per Concrete Class

HIBERNATE

Table per Concrete

- Creates a **table for each** concrete class.
  - (each **class that is not abstract**)
  - Sublcass tables include all superclass properties
  - Polymorphic queries use UNION operator

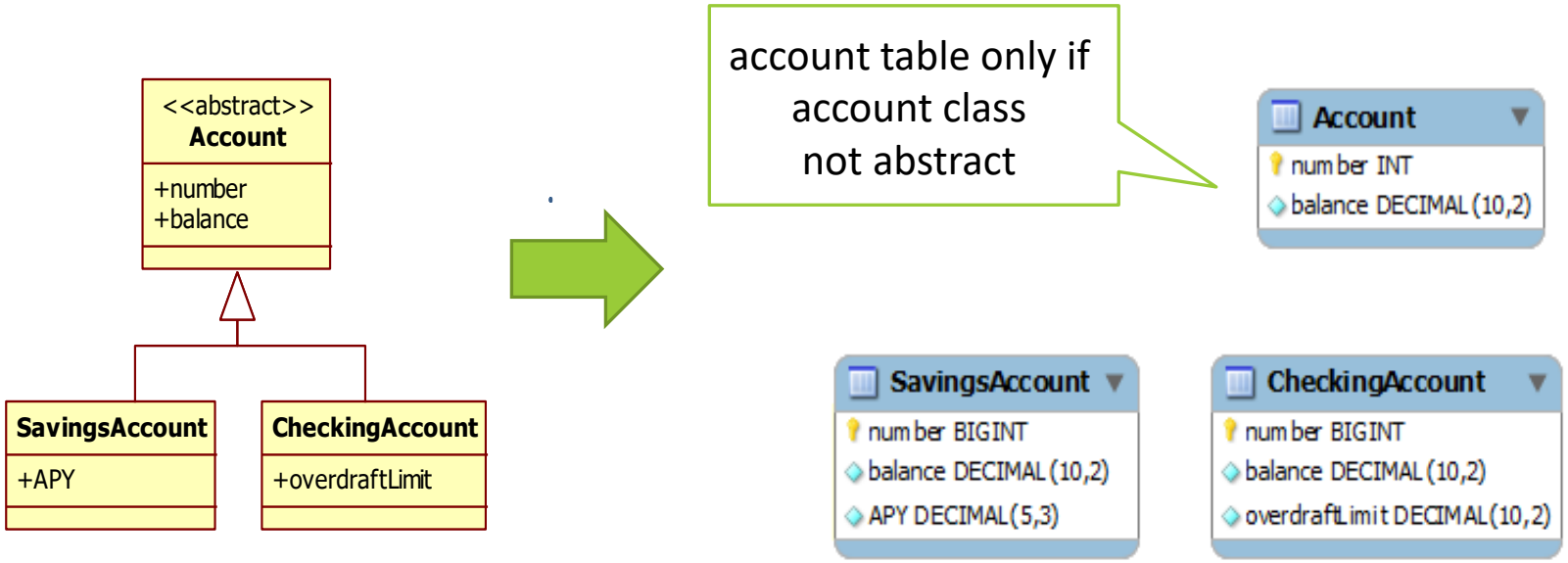


Table per Concrete Mapping

- No identity column

Table per class strategy

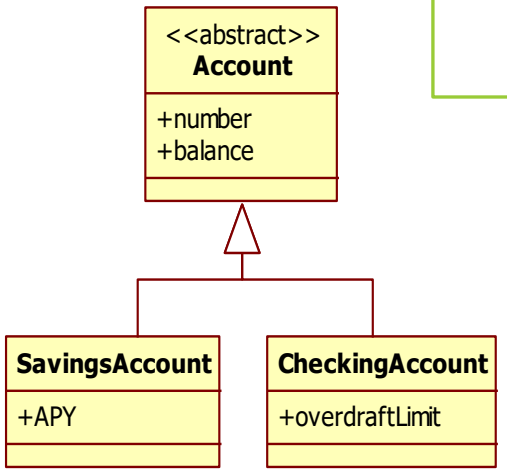
```
@Entity
@Inheritance(strategy=InheritanceType.TABLE_PER_CLASS)
public abstract class Account {
        @Id
        @GeneratedValue(strategy=GenerationType.TABLE)
        private Long number;
        private double balance;
```

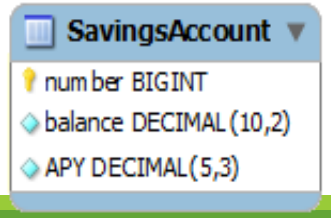
```
@Entity
public class SavingsAccount extends Account {
        private Double APY;
```

```
@Entity
public class CheckingAccount extends Account {
        private Double overdraftLimit;
```

Table ID strategy
(for on MySQL)

Remember: subclasses do not have an **@Id**





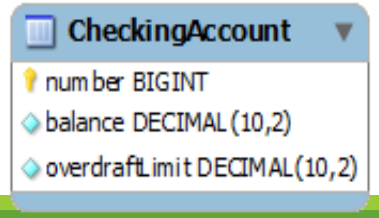


Table per Concrete in Action

SavingsAccount

NUMBER	BALANCE	APY
2	100	2.3

CheckingAccount

NUMBER	BALANCE	OVERDRAFTLIMIT
1	500	200
3	23.5	0

- ✓ Very efficient non-polymorphic
- ✓ Okay with polymorphic queries
- ✗ Cannot use identity column generation
- ✗ Not normalized
- ✗ Redundant columns in each concrete child table
- ✗ More work required to query across tables

SQL for Table per Concrete

```
select
        account0_.number as number0_,
        account0_.balance as balance0_,
        account0_.owner_id as owner3_0_,
        account0_.overdraftLimit as overdraf1_1_,
        account0_.APY as APY2_,
        account0_.clazz_ as clazz_
    from
        ( select
            number,
            balance,
            owner_id,
            overdraftLimit,
            cast(null as int) as APY,
            1 as clazz_
        from
            CheckingAccount
        union
        all select
            number,
            balance,
            owner_id,
            cast(null as int) as overdraftLimit,
            APY,
            2 as clazz_
        from
            SavingsAccount
    ) account0_
```

Discriminator column generated based on which table is currently in UNION

Strategy Recommendation

- Generally **use Single Table**
  - Use JOINED if subclasses have many properties
  - Or if normalization is a priority

- Avoid Table per Concrete
  - Good to know it exists
  - But has some strange parts

Summary

- Inheritance can be emulated:
  - Single Table (with discriminator column)
  - Joined Tables (shared primary key)
  - Table per Concrete (properties in subclasses)
- The default is Single Table
  - And is also the one that is most recommended

Complex Mapping

HIBERNATE

Complex Mapping

- Often you have no choice but to map to an **existing table structure**
  - Your mappings may not be very straight forward
- For example:
  - You can map a class to multiple tables
  - A table can contain multiple classes
  - You may have composite natural keys

Secondary Table

HIBERNATE

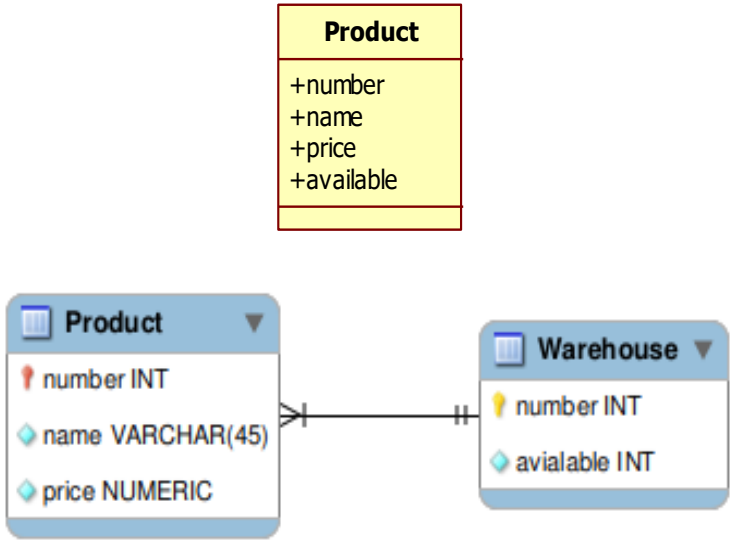
Secondary Tables

- Secondary Tables can be used anywhere
  - **Moves properties** into a separate table
  - Uses shared PK

@SecondayTable specifies table name

```
@Entity
@SecondaryTable(name="Warehouse")
public class Product {
        @Id
        @GeneratedValue(strategy = GenerationType.IDENTITY)
        private Long number;
        private String name;
        private double price;
        @Column(table="Warehouse")
        private boolean available;
        ...
```

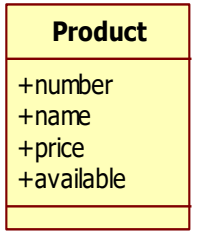
Table="" on @Column

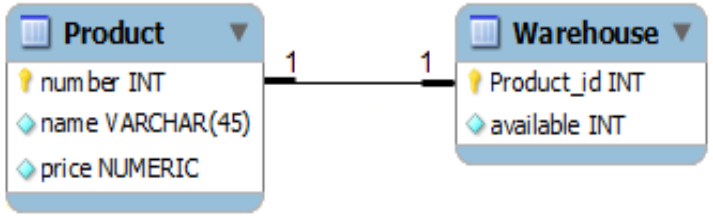


Many Options

- Can specify **multiple tables**
  - Each table can specify **multiple PK join columns**
  - **Column names** on each side can differ

```
@Entity
@SecondaryTables(
                @SecondaryTable(name="Warehouse", pkJoinColumns= {
                                @PrimaryKeyJoinColumn(name="product_id", referencedColumnName="number")
                })
)
public class Product {
        @Id
        @GeneratedValue
        private Long number;
        private String name;
        private double price;
        @Column(table="Warehouse")
        private boolean available;
        ...
```



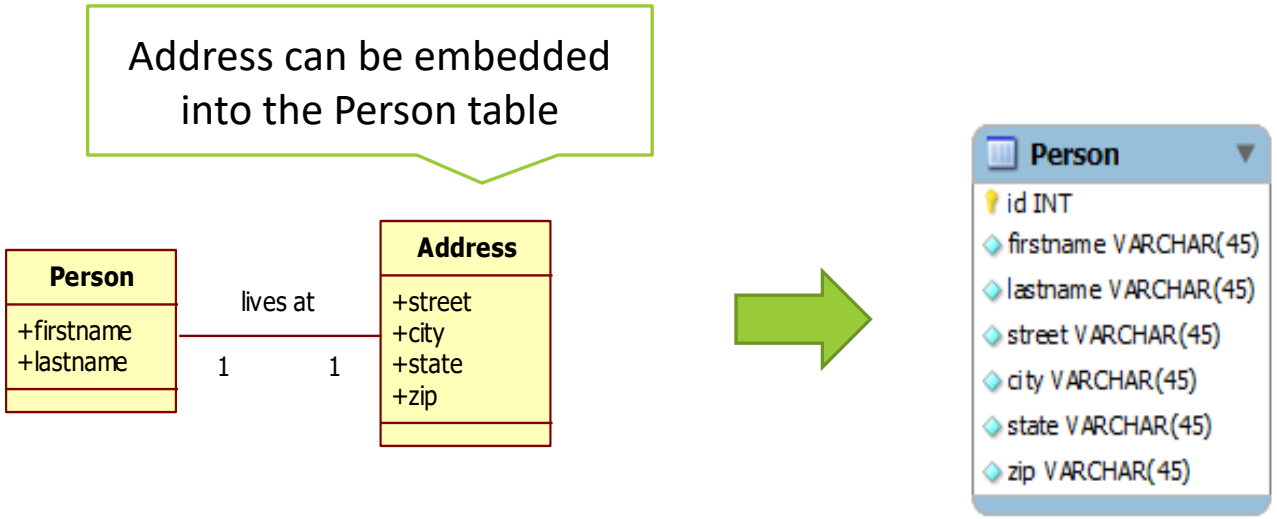


Embedded Classes

HIBERNATE

Embedded Classes

- Called **Value classes** instead of entity classes
  - Like a property value, can be embedded in entity
  - Useful for tight associations (like one to one)



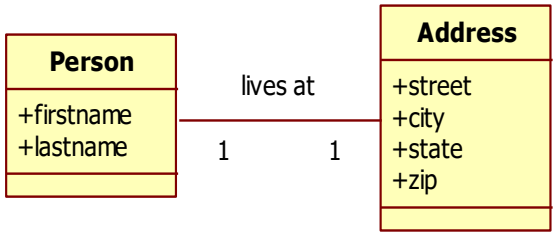
Embeddable

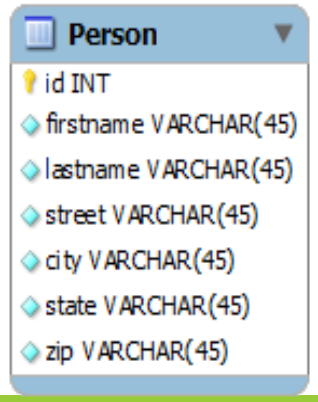
- @Embeddable instead of @Entity
  - No @Id inside an @Embedabble

```
@Embeddable
public class Address {
        private String street;
        private String city;
        private String state;
        private String zip;

        ...
```

```
@Entity
public class Person {
        @Id
        @GeneratedValue(strategy = GenerationType.IDENTITY)
        private Long id;
        private String firstName;
        private String lastName;
        @Embedded
        private Address address;

        ...
```

@Embedded instead of @OneToOne

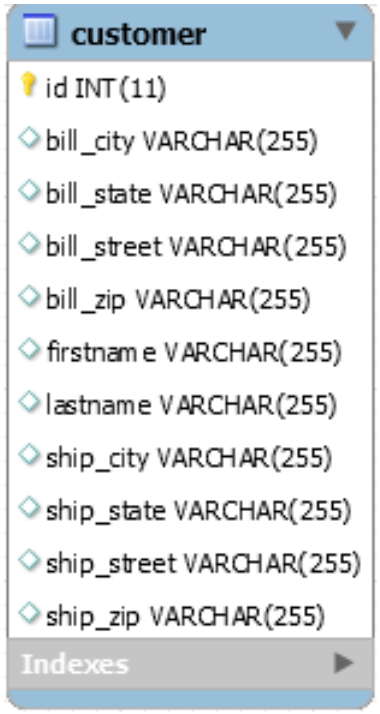




Multiple Embedded

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

 @Embedded
 @AttributeOverrides( {
  @AttributeOverride(name="street", column= @Column (name="ship_street")),
  @AttributeOverride(name="city", column=@Column(name="ship_city")),
  @AttributeOverride(name="state", column=@Column(name="ship_state")),
  @AttributeOverride(name="zip", column=@Column(name="ship_zip"))
 })
 private Address shipping;

 @Embedded
 @AttributeOverrides( {
  @AttributeOverride(name="street", column=@Column(name="bill_street")),
  @AttributeOverride(name="city", column=@Column(name="bill_city")),
  @AttributeOverride(name="state", column=@Column(name="bill_state")),
  @AttributeOverride(name="zip", column=@Column(name="bill_zip"))
 })
 private Address billing;
```

Use @AttributeOverrides to change the column names



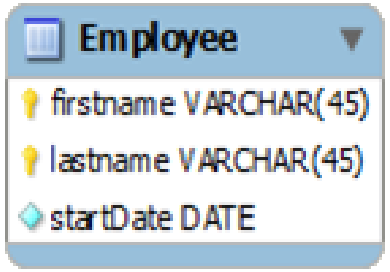
ID	FIRSTNAME	LASTNAME	SHIP_STREET	SHIP_CITY	SHIP_STATE	SHIP_ZIP	BILL_STREET	BILL_CITY	BILL_STATE	BILL_ZIP
1	Frank	Brown	45 N Main St	Chicago	Illinois	51885	100 W Adams St	Chicago	Illinois	60603

Composite Keys

HIBERNATE

Composite Keys

- Composite keys are **multi-column primary keys**
  - By definition natural keys, set by the app
  - Also create **multi-column foreign keys**
  - Generally found in legacy systems



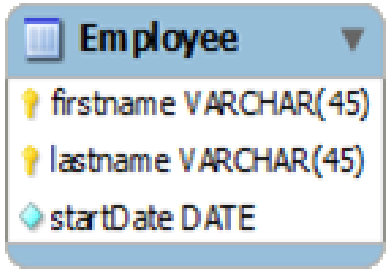
Composite Id

- @Embeddable can create a composite PK
  - Using **@EmbeddedId** annotation
  - -Must **implements Serializable**

```
@Embeddable
public class Name implements Serializable {
        private String firstName;
        private String lastName;
        ...
```

```
@Entity
public class Employee {
        @EmbeddedId
        private Name name;
        @Temporal(TemporalType.DATE)
        private Date startDate;
        ...
```

@EmbeddedID

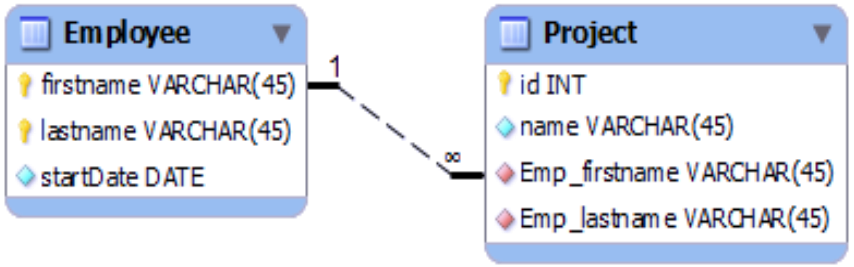


Composite FK

- **Multiple columns** to refer to composite PK

```
@Entity
public class Employee {
        @EmbeddedId
        private Name name;
        @Temporal(TemporalType.DATE)
        private Date startDate;
        @OneToMany(mappedBy="owner")
        private List<Project> projects
                = new ArrayList<>();
        ...
```

Normal mappedBy



Optional @JoinColumns

Defaults to:
owner_firstname
owner_lastname

```
@Entity
public class Project {
        @Id
        @GeneratedValue
        private Long id;
        private String name;
        @ManyToOne
        @JoinColumns({
                @JoinColumn(name = "Emp_firstname", referencedColumnName = "firstname"),
                @JoinColumn(name = "Emp_lastname", referencedColumnName = "lastname")
        })
        private Employee owner;
        ...
```

Summary

- Secondary Tables
  - 1 class to multiple tables
- Embedded classes
  - 1 table, multiple classes
- Composite Keys
  - Multi-column PKs and Fks
  - By using an embedded class as Id

Main Point

Entities and objects relationships can be established through the different types of associations, creating a rich foundation that can represent a real world domain.

Science of Consciousness: *Seek the highest first, start with a good foundation and build rich relationships upon it.*