Inheritance Mapping

CS544: Enterprise Architecture

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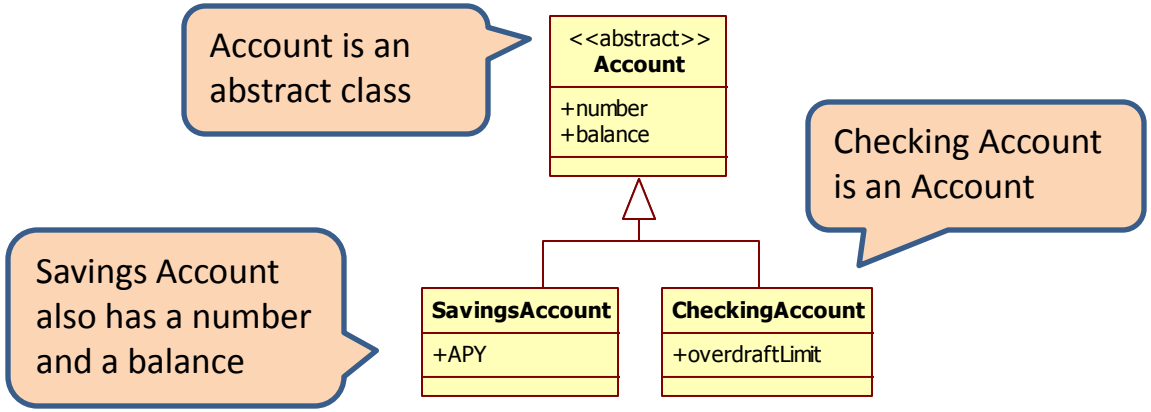
Inheritance

- Using inheritance a class can extend another class
  - Thereby inheriting all its properties and method
  - Often referred to as an ‘is-a’ relationship



- Relational databases don’t have ‘is-a’ relationships
  - There are 3 different ways to emulate inheritance

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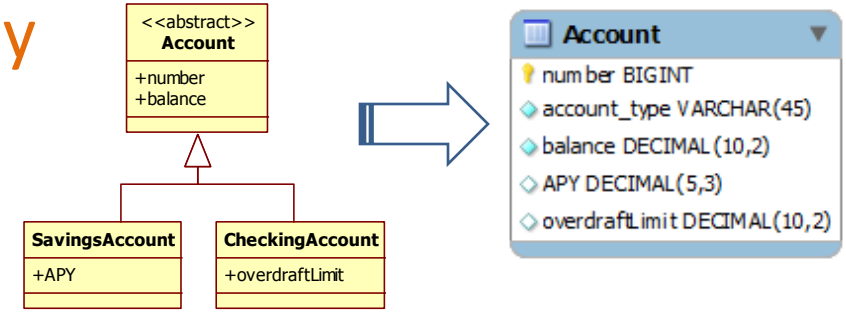
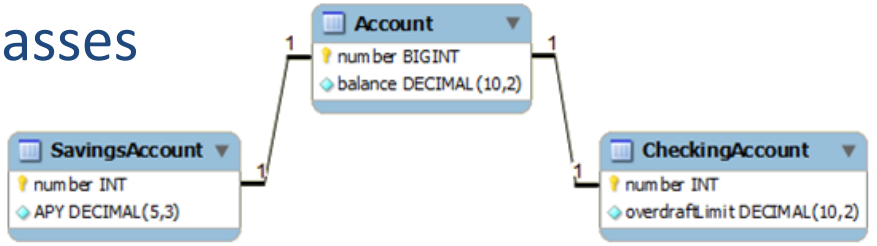
Three ways to map

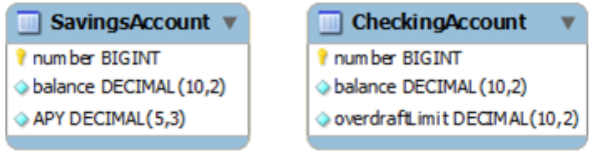
- You can map inheritance in one of three ways:
  - Single Table per Hierarchy
    - De-normalized schema
    - Fast polymorphic queries



  - Joined Tables
    - Normalized & similar to classes
    - Slower queries



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



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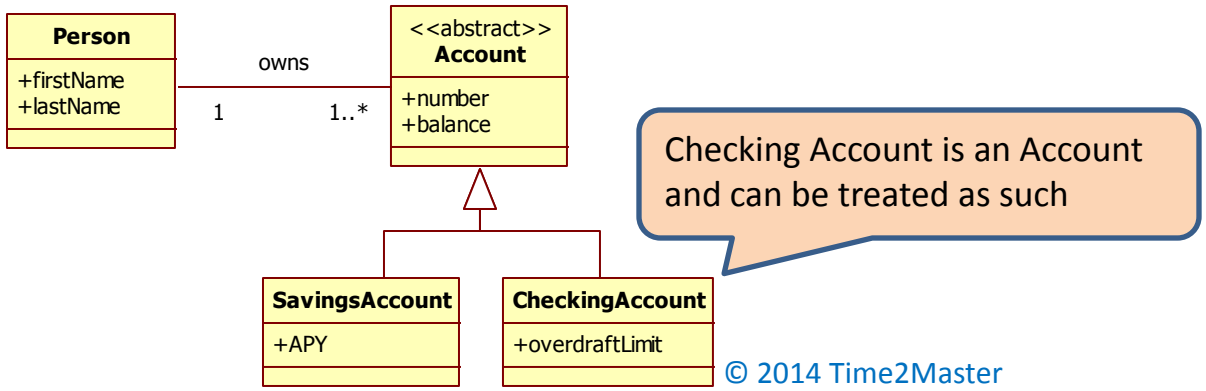
Polymorphism

- Polymorphism is the ability of a subtype to appear and behave like its supertype
- This enables Person to have a list of Account references, which may hold SavingsAccounts and CheckingAccounts.
- A polymorphic query is a query for all objects in a hierarchy, independent of their subtype



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Inheritance Mapping

SINGLE TABLE PER HIERARCHY

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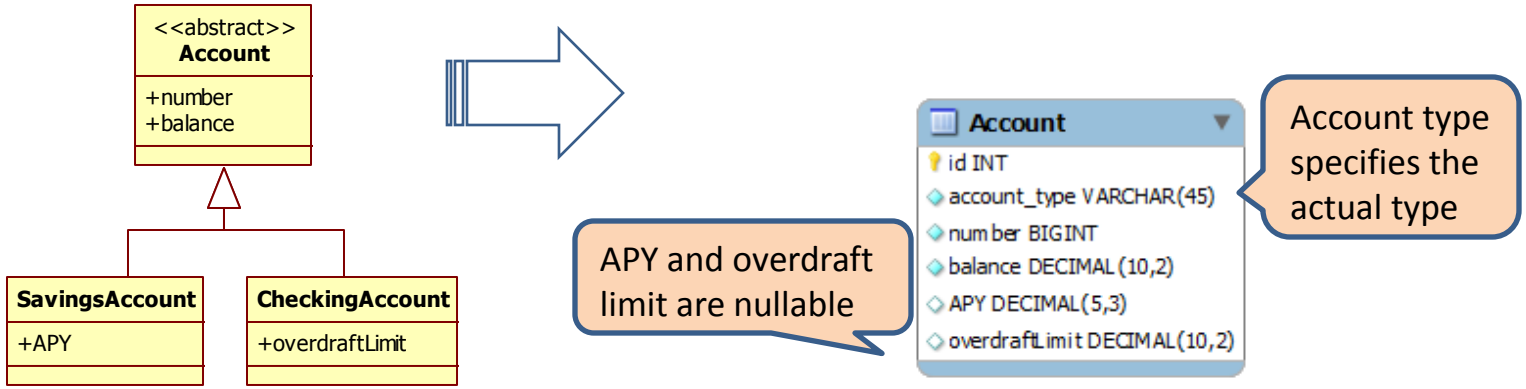
Single Table Implementation

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



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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 is null for checking accounts, overdraft limit is null for savings

+ Simple, Easy to implement
+ Good performance on all queries, polymorphic and non polymorphic

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

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SQL for Single Table

```
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_
```

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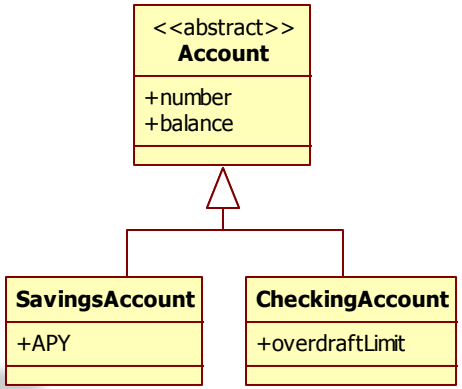
Single Table Mapping

Specify the SINGLE_TABLE strategy

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

  ...
```

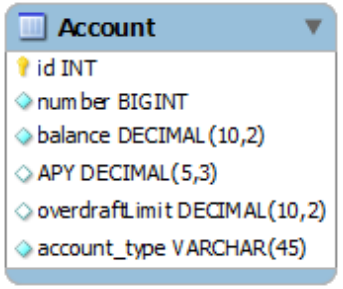
Optional annotation @DiscriminatorColumn




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

  ...
```

Specify discriminator value




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

  ...
```

Specify discriminator value

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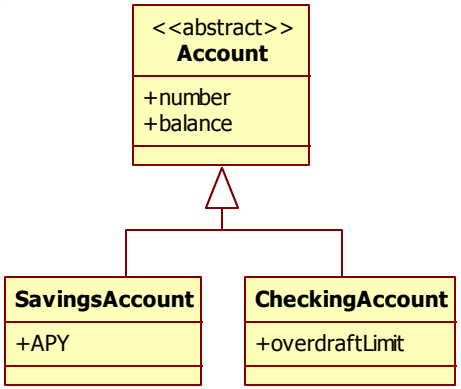
Default

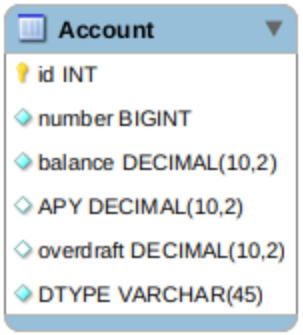
- If you don't add an @Inheritance annotation to a class that is an @Entity and inherits from another @Entity
  - Hibernate will default to single table

```
@Entity
public abstract class Account {
   @Id
   @GeneratedValue
   private long number;
   private double balance;

   ...
```

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

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

...
```





XML

```
<hibernate-mapping package="single">
  <class name="Account" abstract="true">
    <id name="number">
      <generator class="native" />
    </id>

    <discriminator type="string" column="account_type" />

    <property name="balance" />

    <subclass name="SavingsAccount" discriminator-value="savings">
      <property name="APY" />
    </subclass>

    <subclass name="CheckingAccount" discriminator-value="checking">
      <property name="overdraftLimit" />
    </subclass>
  </class>
</hibernate-mapping>
```

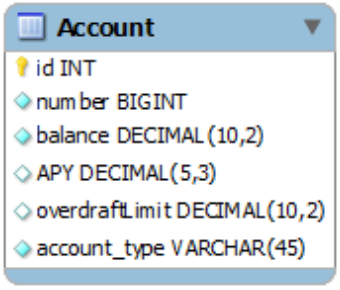
Abstract account class

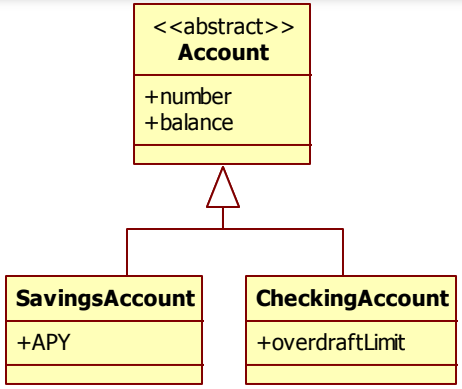
<discriminator> tag has to be after <id> and before <property>

Account properties

Subclass definition included inside superclass

Discriminator values optional





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Inheritance Mapping

JOINED TABLES

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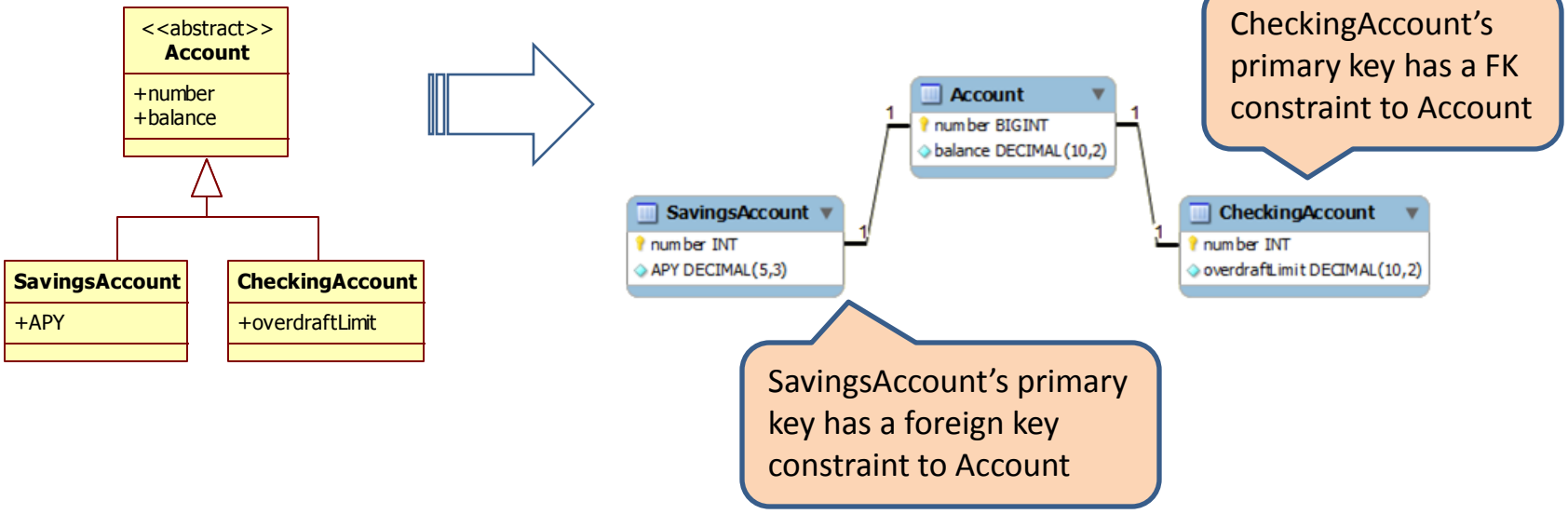
Joined Tables Implementation

- The Joined Tables Strategy uses FK ‘has a’ relations to emulate ‘is a’ relations
  - Uses Foreign Key constraints on the Primary Keys
  - Queries use JOINs to included needed tables



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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 is similar to domain view

– Inserting or updating an entity results in multiple insert or update statements
– Necessary joins can give lower query performance

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Joined – No Discriminator Value

```
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
```

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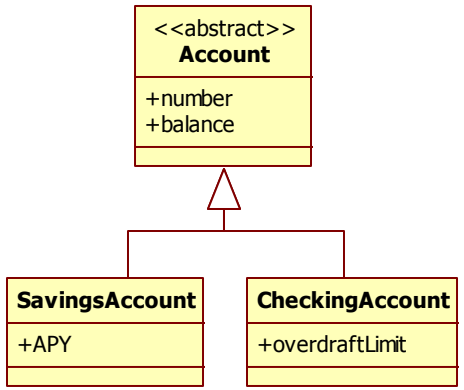
Joined

Just specify the inheritance strategy, nothing else

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

   ...
```



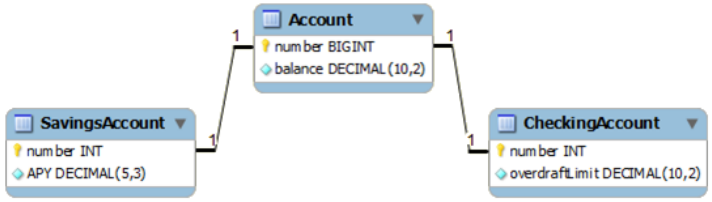

```
@Entity
public class SavingsAccount extends Account {
   private double APY;

   ...
```

Subclasses can be mapped as normal entity classes, but without identifiers

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

   ...
```



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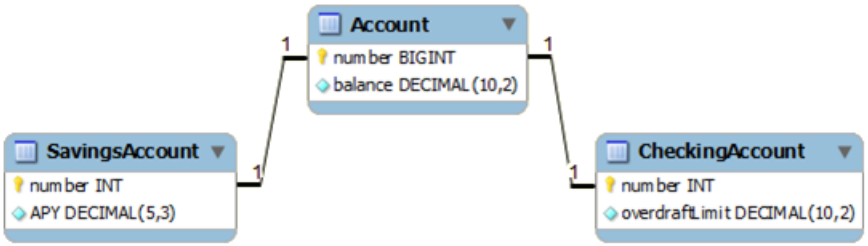
XML

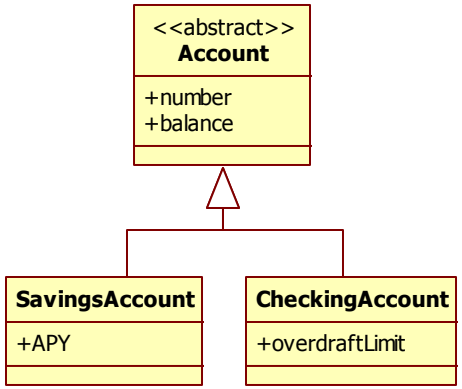
```
<hibernate-mapping package="single">
  <class name="Account" abstract="true">
    <id name="number">
      <generator class="native" />
    </id>

    <property name="balance" />

    <joined-subclass name="SavingsAccount">
      <key column="number" />
      <property name="APY" />
    </joined-subclass>

    <joined-subclass name="CheckingAccount">
      <key column="number" />
      <property name="overdraftLimit" />
    </joined-subclass>
</class>
</hibernate-mapping>
```

Abstract account class

Joined Subclasses are also specified inside the super class

Need an additional <key> tag to specify the PK / join column in the subclasses





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Inheritance Mapping

TABLE PER CONCRETE CLASS

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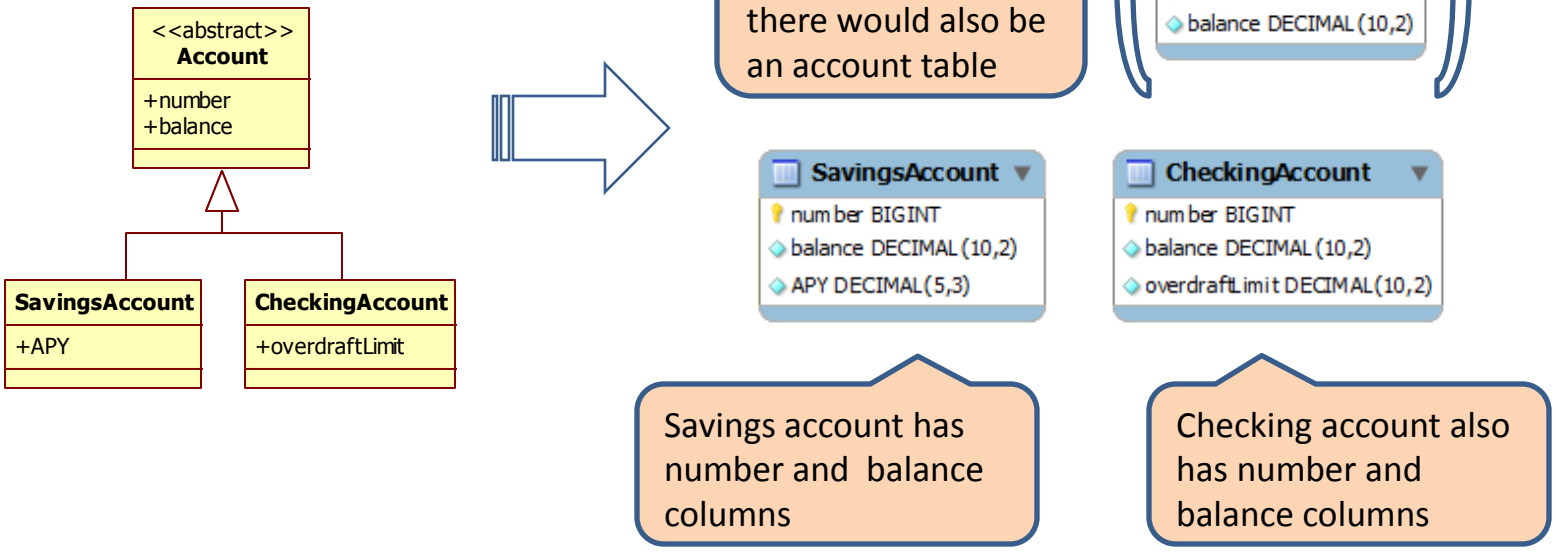
Table per Concrete Class

- Table per Concrete Class uses a table for each concrete (non-abstract) class
  - Subclass tables include **all** superclass properties
  - Polymorphic queries use UNION operations



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Concrete Class 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 queries
+ Decently efficient polymorphic queries

– Cannot use Identity column ID generation
– Polymorphic one too many associations only supported for bi-directional associations
– Subclass properties cannot use primitives
– JPA does not require its implementation (optional)

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Table Per Concrete – No Discriminator Value

```
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_
```

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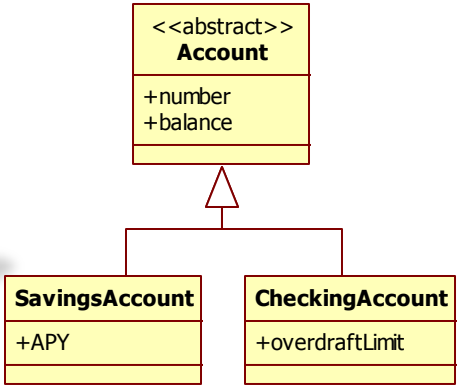
Table per Class

Just specify the inheritance strategy, nothing else

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

   ...
```

Id generation can not use identity column

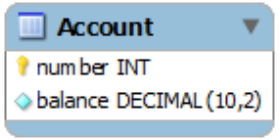


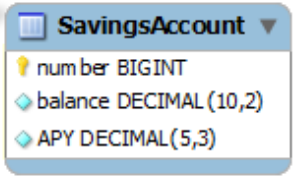
Normal @Entity mapping

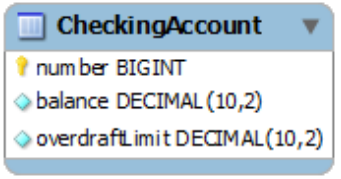
```
@Entity
public class SavingsAccount extends Account {
   private Double APY;

   ...
```

Java.util.Double instead of primitive double type








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

   ...
```

Java.util.Double instead of primitive double type

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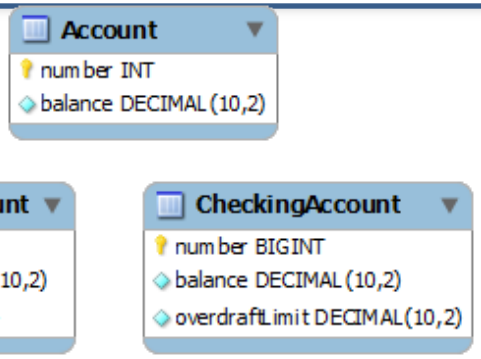
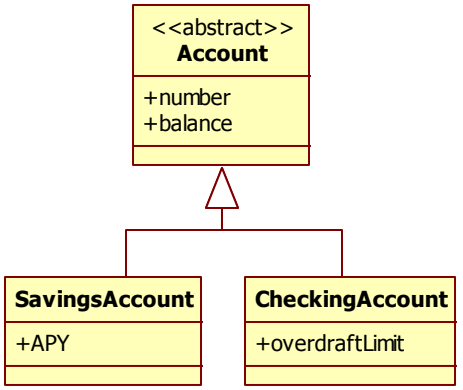
XML

```
<hibernate-mapping package="concrete">
  <class name="Account" abstract="true">
    <id name="number">
      <generator class="hilo" />
    </id>

    <property name="balance" />

    <union-subclass name="SavingsAccount">
      <property name="APY" />
    </union-subclass>

    <union-subclass name="CheckingAccount">
      <property name="overdraftLimit" />
    </union-subclass>
  </class>
</hibernate-mapping>
```

Identity generation can not use identity column

<union-subclass> tag





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Inheritance Mapping

WRAPPING UP

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Recommendations

- If subclasses don’t contain a lot of properties use single table per hierarchy
- If subclasses have many properties it is generally best to use joined tables
- Avoid using table per concrete class unless you do not have any polymorphic associations

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Active Learning

- What are the advantages and disadvantages of the joined table strategy?

- Why should we not specify @Id on sub classes?

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Module Summary

- In this module we covered the different ways to map inheritance with Hibernate
  - Single Table: De-normalized schema, but very efficient queries
  - Joined Tables: Normalized schema, but less efficient queries
  - Table per Concrete: has some issues, but is very efficient if polymorphism is not a priority
- Which strategy to use depends on your business needs, when in doubt the joined table is the most flexible, although slower

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Main Point

- Inheritance can be mapped in 3 ways: single table, joined tables, and table per concrete. Single table is the default approach, although joined tables is better to use when there are many properties in the subclasses. Table per concrete class is mainly for legacy systems.
- *Science of Consciousness*: Life is found in layers, more abstract layers have greater flexibility and power.

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