



Component and Inheritance Mapping

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Topics in This Section

- Understand the difference between Components and Entities
- Walk through some uses of Components, and their mapping
- Look at different strategies and implementations for realizing inheritance

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Component

- Refers to the UML modeling term of composition
- Does not exist on its own; dependent on a parent object
 - Does not have a table or identifier in the database
 - Only associated to a single parent class
- Commonly referred to as a “*has a*” relationship
 - An AccountOwner *has an* Address

Entity

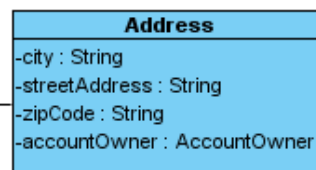
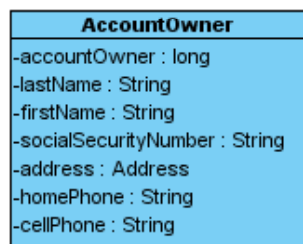
- 1st class citizen -- lives on its own
- Has its own table and identifier
- Can be made up of multiple components
- Can be related/associated to other entities

Entity/Component Example

- **'AccountOwner' is an Entity**
 - Can lives on its own
 - Has its own id
- **'Address' is a component of 'AccountOwner'**
 - Non-existent without AccountOwner
 - No id of its own.

ACCOUNT_OWNER

Column Name	Data Type	Nullable
ACCOUNT_OWNER_ID	NUMBER	No
LAST_NAME	VARCHAR2(50)	No
FIRST_NAME	VARCHAR2(50)	No
SOCIAL_SECURITY_NUMBER	VARCHAR2(50)	No
STREET_ADDRESS	VARCHAR2(50)	No
CITY	VARCHAR2(50)	No
STATE	VARCHAR2(50)	No
ZIP_CODE	VARCHAR2(10)	No
HOME_PHONE	VARCHAR2(20)	Yes
CELL_PHONE	VARCHAR2(20)	Yes



Using Components

- 1. Determine your domain model**
 - Which objects are best suited to be a component?
- 2. Create your database tables**
 - Model your components accordingly within entity tables
- 3. Create your Java classes**
 - One for each entity, and one for each component
 - Setup your components within the entity classes
- 4. Write the Hibernate mapping file for the entity, using the embedded component tag within it to identify the component class.**

Mapping a Component

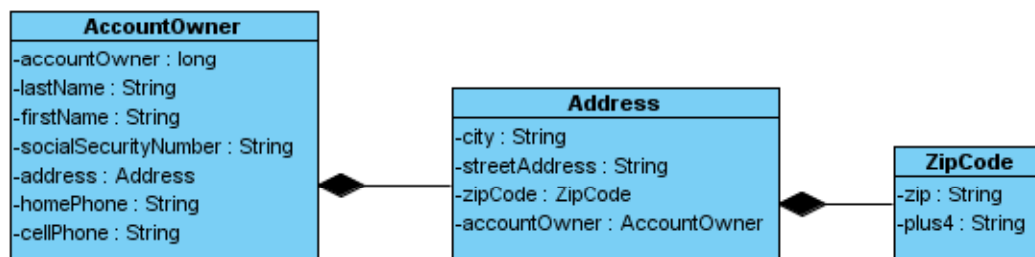
```
<class name="courses.hibernate.vo.AccountOwner"
      table="ACCOUNT_OWNER">
  <id name="accountOwnerId" column="ACCOUNT_OWNER_ID">
    <generator class="native" />
  </id>
  <property name="lastName" column="LAST_NAME" type="string" />
  <property name="firstName" column="FIRST_NAME" type="string" />
  <property name="socialSecurityNumber"
            column="SOCIAL_SECURITY_NUMBER" type="string" />
  <component name="address" class="courses.hibernate.vo.Address">
    <parent name="accountOwner"/>
    <property name="streetAddress" column="STREET_ADDRESS"
              type="string" />
    <property name="city" column="CITY" type="string" />
    <property name="state" column="STATE" type="string" />
    <property name="zipCode" column="ZIP_CODE" type="string" />
  </component>
  <property name="homePhone" column="HOME_PHONE" type="string" />
  <property name="cellPhone" column="CELL_PHONE" type="string" />
</class>
```

Nested Components

- Component 'Address' has *nested* component 'ZipCode'

– Example: 12222-1234

Column Name	Data Type	Nullable
ACCOUNT_OWNER_ID	NUMBER	No
LAST_NAME	VARCHAR2(50)	No
FIRST_NAME	VARCHAR2(50)	No
SOCIAL_SECURITY_NUMBER	VARCHAR2(50)	No
STREET_ADDRESS	VARCHAR2(50)	No
CITY	VARCHAR2(50)	No
STATE	VARCHAR2(50)	No
ZIP_CODE	VARCHAR2(5)	No
ZIP_PLUS_FOUR	VARCHAR2(4)	Yes
HOME_PHONE	VARCHAR2(50)	Yes
CELL_PHONE	VARCHAR2(50)	Yes



Mapping Nested Components

```
<class name="courses.hibernate.vo.AccountOwner"
    table="ACCOUNT_OWNER">
    ...
    <component name="address" class="courses.hibernate.vo.Address">
        <parent name="accountOwner"/>
        <property name="streetAddress" column="STREET_ADDRESS"
            type="string" />
        <property name="city" column="CITY" type="string" />
        <property name="state" column="STATE" type="string" />
        <component name="zipCode"
            class="courses.hibernate.vo.ZipCode">
            <property name="zip" column="ZIP_CODE" type="string" />
            <property name="plus4" column="ZIP_PLUS_FOUR"
                type="string" />
        </component>
    </component>
    ...
</class>
```

Collection of Components

```
<class name="courses.hibernate.vo.Account" table="ACCOUNT">
  ...
  <set name="accountOwnerAddresses" table="ACCOUNT_ACCOUNT_OWNER">
    <key column="ACCOUNT_ID" />
    <composite-element class="courses.hibernate.vo.Address">
      <property name="streetAddress" type="string"
        formula="(SELECT AO.STREET_ADDRESS FROM ACCOUNT_OWNER AO
          WHERE AO.ACCOUNT_OWNER_ID = ACCOUNT_OWNER_ID)"/>

      <property name="city" type="string"
        formula="(SELECT AO.CITY FROM ACCOUNT_OWNER AO WHERE
          AO.ACCOUNT_OWNER_ID = ACCOUNT_OWNER_ID)" />

      <property name="state" type="string"
        formula="(SELECT AO.STATE FROM ACCOUNT_OWNER AO WHERE
          AO.ACCOUNT_OWNER_ID = ACCOUNT_OWNER_ID)" />
    </composite-element>
  </set>
  ...
</class>
```

Component as Entity ID

- **Done with or without a separate Java class**
 - If using Java class
 - Must implement Comparable and Serializable
 - Must define 'class' attribute in mapping file
- **If composite key contains identifiers from associations:**
 - Set the id value when you set the corresponding association on the main object
 - Set insert='false' and update='false' on the association on the main object

Component as Entity ID

- **Example: EBill uses EBillId component as primary key**
 - EBillId component class contains attributes required to uniquely identify the EBill

EBillId Class

```
public class EBillId implements
    Comparable<EBillId>, Serializable {
    private long accountId;
    private long ebillerId;
    private Date dueDate;
    ...
    // getters and setters
    ...
}
```

Component as Entity ID

- **Example: EBill uses EBillId component as primary key**
 - In EBill entity class, EBillId values are set as appropriate setters are called.

EBill Class

```
public class EBill {
    private EBillId ebillId = new EBillId();
    private EBiller ebiller;
    ...
    protected void setEbiller(EBiller ebiller) {
        this.ebiller = ebiller;
        ebillId.setEbillerId(ebiller.getEbillerId());
        ...
    }
    ...
}
```

Component as Entity ID

- Example: EBill uses EBillId component as primary key

EBill Mapping File

```
<class name="courses.hibernate.vo.EBill" table="EBILL">
  <composite-id name="ebillId"
    class="courses.hibernate.vo.EBillId">
    <key-property name="accountId" column="ACCOUNT_ID"
      type="long"/>
    <key-property name="ebillerId" column="EBILLER_ID"
      type="long"/>
    <key-property name="dueDate" column="DUE_DATE"
      type="timestamp"/>
  </composite-id>
  ...
  <!-- Must have insert="false" update="false" because ids for the objects are
  part of the composite key. The relationships are managed via the composite
  key elements rather than the M:1 relationship. -->
  <many-to-one name="ebiller" column="EBILLER_ID"
    class="courses.hibernate.vo.EBiller" access="field"
    insert="false" update="false" />
  ...
</class>
```

Component as Entity ID Caveat

- Using a Component as an Entity ID and not using a separate class to represent it can be troublesome
- You can *not* simply pass in the attributes which make up the key into a `session.get ()` method
 - `session.get(EBill.class, int x, int y)`
 - No such api on Session object
- Need to write a separate Hibernate query to bring back the object



Inheritance

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Inheritance

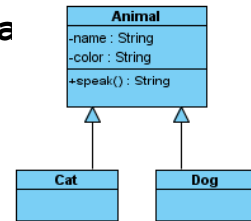
- **Allows for logical affiliation of classes with common state and/or behavior**
- **Commonly referred to as an “*is a*” relationship**
 - A **Cat** *is a* **Animal**
 - A **Dog** *is a* **Animal**
- **Polymorphism**
 - Dynamic realization of subclass behavior while treating the object as an instance of its superclass

Polymorphism

```
public class Animal {
    public String speak() {
        return "Generic Hello";
    }
}

public class Cat extends Animal {
    public String speak() {
        return "Meow";
    }
}

public class Dog extends Animal {
    public String speak() {
        return "Woof";
    }
}
```



Polymorphism

```
public class Farm {
    List<Animal> animals =
    someDAO.getAnimals();
    for (int index=0; index < animals.size();
        index++) {
        Animal someAnimal = animals.get(index);
        System.out.println(someAnimal.speak());
    }
}
```

Even though the variable type in our List is 'Animal'...

Assuming the list of animals returned included (in order) a cat, then a dog, the output would be:

Meow

Woof

... polymorphism allows each instance to make use of its own implementation

Inheritance Realization

- **Easy to do in an object oriented language**
 - Java: Use ‘extends’ or ‘implements’ keyword
- **Not so easy to do in a relational database**
 - Tables do not ‘extend’ from each other
 - Part of the ‘impedance mismatch’ problem
- **How do we get around this?**
 - Four approaches through Hibernate
 - Hibernate implicit polymorphism
 - Table-per-concrete class
 - Table-per-class-hierarchy
 - Table-per-subclass

Modeling Inheritance

- 1. Determine your domain model**
 - What objects have hierarchical relationships?
- 2. Choose your inheritance strategy**
 - Hibernate implicit polymorphism
 - Table-per-concrete class
 - Table-per-class-hierarchy
 - Table-per-subclass
- 3. Create your database tables based on the chosen strategy**
- 4. Code your Java objects, using ‘extends’ or ‘implements’**
- 5. Write your Hibernate mapping file using the appropriate subclass tags**

Implicit Polymorphism

- **Database**
 - *One* database table *per* concrete class
- **Hibernate Mapping Files**
 - *Separate mapping files for each inherited class*
 - Like normal, including any inherited properties
- **Default Behavior**
 - Out of the box Hibernate will automatically recognize any Java inheritance associations

Implicit Polymorphism

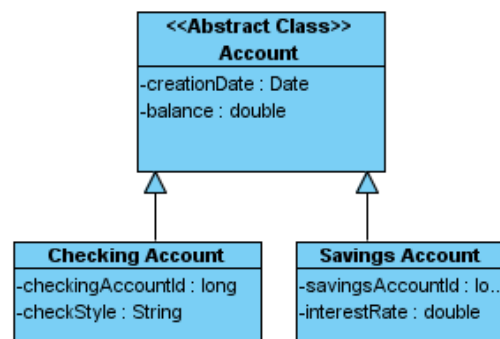
- **One table per concrete class**

CHECKING_ACCOUNT

Column Name	Data Type	Nullable
CHECKING_ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
CHECK_STYLE	VARCHAR2(50)	No

SAVINGS_ACCOUNT

Column Name	Data Type	Nullable
SAVINGS_ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
INTEREST_RATE	NUMBER(10,2)	No



Implicit Polymorphism

- **CheckingAccount mapping file**

```
<class name="courses.hibernate.vo.CheckingAccount"
      table="CHECKING_ACCOUNT">

  <id name="checkingAccountId" column="CHECKING_ACCOUNT_ID">
    <generator class="native"/>
  </id>

  <property name="creationDate" column="CREATION_DATE"
           type="timestamp"      update="false"/>

  <property name="balance" column="BALANCE" type="double"/>

  <property name="checkStyle" column="CHECK_STYLE"
           type="string"/>
</class>
```

Implicit Polymorphism

- **SavingsAccount mapping file**

```
<class name="courses.hibernate.vo.SavingsAccount"
      table="SAVINGS_ACCOUNT">

  <id name="savingsAccountId" column="SAVINGS_ACCOUNT_ID">
    <generator class="native"/>
  </id>

  <property name="creationDate" column="CREATION_DATE"
           type="timestamp"      update="false"/>

  <property name="balance" column="BALANCE" type="double"/>

  <property name="interestRate" column="INTEREST_RATE"
           type="double"/>
</class>
```

Implicit Polymorphism

- **Advantages**

- Get it for free. Hibernate automatically scans classes on startup (including inheritance); No additional configuration/mapping needed
- Not a lot of nullable columns (*good for integrity*)
- Queries against individual types are fast and simple

Implicit Polymorphism

- **Disadvantages**

- Makes handling relationships difficult
 - One-to-many relationships typically require a foreign key, but inherited associations can't key to both tables; Databases don't support it (Example: AccountOwner:Account)
- Polymorphic queries are process intensive
 - For queries against the superclass, Hibernate executes multiple queries
 - **SELECT * FROM CHECKING_ACCOUNT WHERE ACCOUNT_OWNER_ID=?**
 - **SELECT * FROM SAVINGS_ACCOUNT WHERE ACCOUNT_OWNER_ID=?**
- Database schema evolution more complex
 - Need to add the same column to multiple tables
 - Integrity constraints might have to span multiple tables

Table-per-concrete class

- **Database**
 - *One* database table *per* concrete class
- **Hibernate Mapping**
 - *Single mapping file*
 - Based on superclass
 - Includes 'union-subclass' definitions for inherited classes

Table-per-concrete class

- **One table per concrete class**

CHECKING_ACCOUNT

Column Name	Data Type	Nullable
ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
CHECK_STYLE	VARCHAR2(50)	No

SAVINGS_ACCOUNT

Column Name	Data Type	Nullable
ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
INTEREST_RATE	NUMBER(10,2)	No

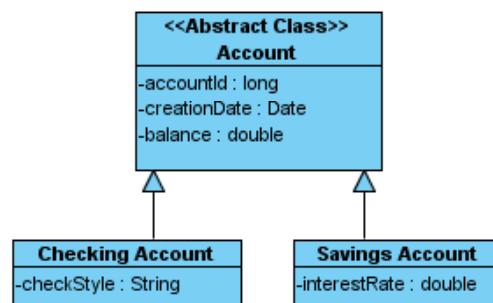


Table-per-concrete class

- **Account Mapping File**

```
<class name="Account" abstract="true">
  <id name="accountId" column="ACCOUNT_ID" type="long">
    <generator class="native"/>
  </id>

  <property name="creationDate" column="CREATION_DATE"
    type="timestamp"/>
  <property name="balance" column="BALANCE"
    type="double"/>

  <union-subclass name="courses.hibernate.vo.SavingsAccount"
    table="SAVINGS_ACCOUNT">
    <property name="interestRate"
      column="INTEREST_RATE" type="double"/>
  </union-subclass>
  <union-subclass name="courses.hibernate.vo.CheckingAccount"
    table="CHECKING_ACCOUNT">
    <property name="checkStyle" column="CHECK_STYLE"
      type="string"/>
  </union-subclass>
</class>
```

Table-per-concrete class

- **Advantages**

- Shared mapping of common elements
 - Shared database id
- Not a lot of nullable columns (*good for integrity*)
- Queries against individual types are fast and simple
- Less SQL statements generated with use of 'Union' for polymorphic queries

- **Disadvantages**

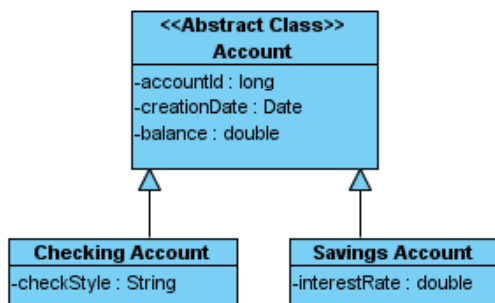
- Still have difficulty with relationships
 - Foreign keying to two tables not possible
- Database schema evolution still more complex
 - Need to add the same column to multiple tables
 - Integrity constraints might have to span multiple tables

Table-per-class-hierarchy

- **Database**
 - One database table for all subclasses
 - Denormalized table has columns for all attributes
- **Hibernate Mapping**
 - Single mapping file still based on superclass
 - Includes ‘subclass’ definitions for inherited classes
 - Use ‘discriminator’ column/field to identity concrete type

Table-per-class-hierarchy

- **One table for all inherited classes**



ACCOUNT

Column Name	Data Type	Nullable
ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No
ACCOUNT_TYPE	VARCHAR2(1)	No
CHECK_STYLE	VARCHAR2(50)	Yes
INTEREST_RATE	NUMBER(10,2)	Yes

ACCOUNT_ID	CREATION_DATE	BALANCE	ACCOUNT_TYPE	CHECK_STYLE	INTEREST_RATE
1	17-AUG-08 06.03.27.000000 PM	1000	C	Sea Creatures	-
2	09-AUG-08 06.03.45.000000 PM	6000	C	Angels	-
3	09-SEP-08 06.04.24.000000 PM	12000	S	-	.25
4	09-SEP-08 06.04.53.000000 PM	8000	S	-	4.2

Table-per-class-hierarchy

- **Account Mapping File**

```
<class name="Account" table="ACCOUNT" abstract="true">
  <id name="accountId" column="ACCOUNT_ID" type="long"
    <generator="native"/>
  </id>
  <discriminator column="ACCOUNT_TYPE" type="string"/>
  <property name="creationDate" column="CREATION_DATE"
    type="timestamp"/>
  <property name="balance" column="BALANCE" type="double"/>

  <subclass name="courses.hibernate.vo.SavingsAccount"
    discriminator-value="S">
    <property name="interestRate" column="INTEREST_RATE"/>
  </subclass>

  <subclass name="courses.hibernate.vo.CheckingAccount"
    discriminator-value="C">
    <property name="checkStyle" column="CHECK_STYLE"/>
  </subclass>
</class>
```

Table-per-class-hierarchy

- **Advantages**

- Simple
- Fast reads/writes, even across types

- **Disadvantages**

- Lots of nullable columns
 - Possible data integrity concern
- Denormalized table generally considered bad database design

Table-per-subclass

- **Database**

- One database table for the superclass AND one per subclass
 - Shared columns in superclass table
 - Subclass tables have their object-specific columns

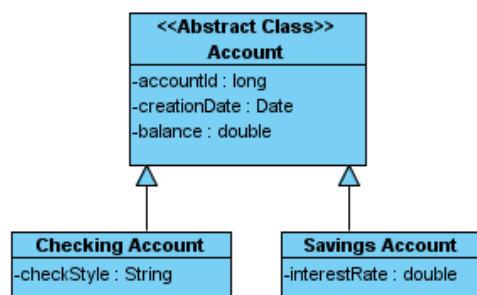
- **Hibernate Mapping File**

- Single mapping file based on the superclass
- Includes ‘**joined-subclass**’ definitions for inherited classes

Table-per-subclass

- **Every class that has persistent properties has its own table**

- Each table contains a primary key, and non-inherited properties
- Inheritance is realized through foreign keys



Column Name	Data Type	Nullable
ACCOUNT_ID	NUMBER	No
CREATION_DATE	TIMESTAMP(6)	No
BALANCE	NUMBER(10,2)	No

Column Name	Data Type	Nullable
CHECKING_ACCOUNT_ID	NUMBER	No
CHECK_STYLE	VARCHAR2(50)	No

Column Name	Data Type	Nullable
SAVINGS_ACCOUNT_ID	NUMBER	No
INTEREST_RATE	NUMBER(10,2)	No

Table-per-subclass

- **Account Mapping File**

```
<class name="Account" table="ACCOUNT" abstract="true">
  <id name="accountId" column="ACCOUNT_ID" type="long">
    <generator class="native"/>
  </id>
  <property name="creationDate" column="CREATION_DATE"
    type="timestamp"/>
  <property name="balance" column="BALANCE"
    type="double"/>
  <joined-subclass name="courses.hibernate.vo.SavingsAccount"
    table="SAVINGS_ACCOUNT">
    <key column="SAVINGS_ACCOUNT_ID"/>
    <property name="interestRate" column="INTEREST_RATE"
      type="double"/>
  </joined-subclass>
  <joined-subclass name="courses.hibernate.vo.CheckingAccount"
    table="CHECKING_ACCOUNT">
    <key column="CHECKING_ACCOUNT_ID"/>
    <property name="checkStyle" column="CHECK_STYLE"
      type="string"/>
  </joined-subclass>
</class>
```

Table-per-subclass

- **Advantages**

- Normalized schema
 - Schema evolution and integrity are straight forward
- Reduced number of SQL statements produced
 - Hibernate uses inner joins for subclass queries, outer joins for polymorphic ones

- **Disadvantages**

- Can have poor performance for complex systems
 - Requires many joins or sequential reads for queries

When to use Which

- Leave implicit polymorphism for queries against interfaces (*based on behavior, not different attributes*)
- If you rarely require polymorphic queries, lean towards table-per-concrete-class.
- If polymorphic behavior is required, AND subclasses have only a few distinct properties, try table-per-class-hierarchy
- If polymorphic AND many distinct properties, look at table-per-subclass or table-per-concrete-class, weighing the cost of joins versus unions.

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Wrap-up

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Summary

- **In this lecture, we:**
 - Saw how Components are different from Entities
 - Entities have their own IDs
 - Components are dependant on Entities
 - Learned how to use Components and Entities to represent
 - Subsets of logical data,
 - Identifiers for Entities,
 - Talked about the different methods of modeling inheritance relationships through Java/Database/Hibernate, and where each one is best suited.
 - Hibernate implicit polymorphism
 - Table-per-concrete class
 - Table-per-class-hierarchy
 - Table-per-subclass

Preview of Next Sections

- **Stages of an object's lifecycle within Hibernate**
- **Closer look at the Hibernate persistence process**
- **Session Management**



Questions?

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