Inheritance

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Content

- Encapsulation
  - i.e., a class contains everything it needs and nothing more!
- Polymorphism (multiple shapes or forms)
  - i.e., **java objects** can have multiple identifiers, that way different objects can be grouped as if they are the **same type** under certain condition
- Inheritance
  - Passing down traits or characteristics from a parent to their child like skin, hair color

Example

Building a bank account manager

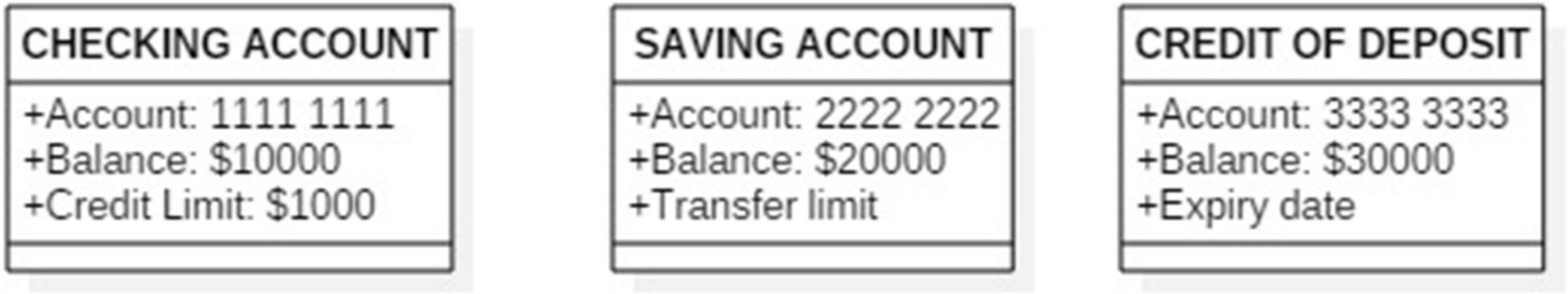
- Assume you have 3 different types of accounts

- **Checking account**
- **Saving account**
- **Certificate of deposit**

- They **all share similar information** like the account number and the balance in them
- But they also have **different attributes**

Example…

Building a bank account manager



CHECKING ACCOUNT

+Account: 1111 1111
+Balance: $10000
+Credit Limit: $1000

SAVING ACCOUNT

+Account: 2222 2222
+Balance: $20000
+Transfer limit

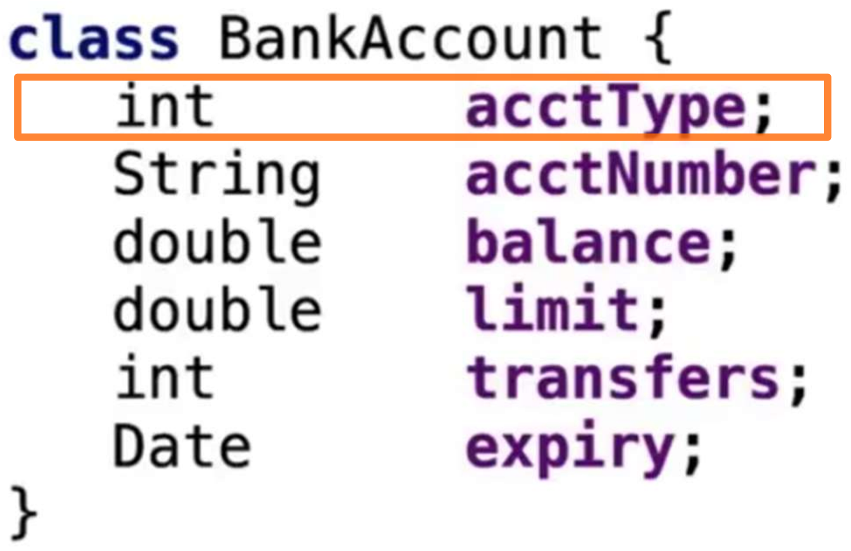
CREDIT OF DEPOSIT

+Account: 3333 3333
+Balance: $30000
+Expiry date

Example...

Building a bank account manager

- Basically you can implement that in one **single class** in java



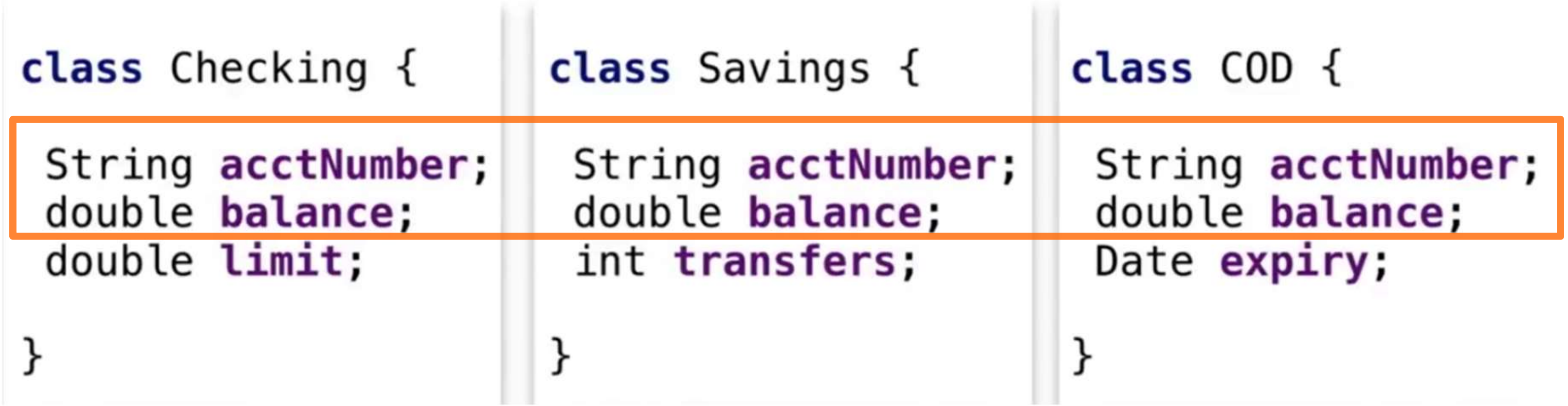
```
class BankAccount {
    int       acctType;
    String    acctNumber;
    double    balance;
    double    limit;
    int       transfers;
    Date      expiry;
}
```

- ➔ that means, **everything** is included in that class!

Example…

Building a bank account manager

- Another way is to create a class for each account type
  - **each class** would only contain *the fields* and *methods* that make sense for that class



```
class Checking {

 String acctNumber;
 double balance;
 double limit;

}
```

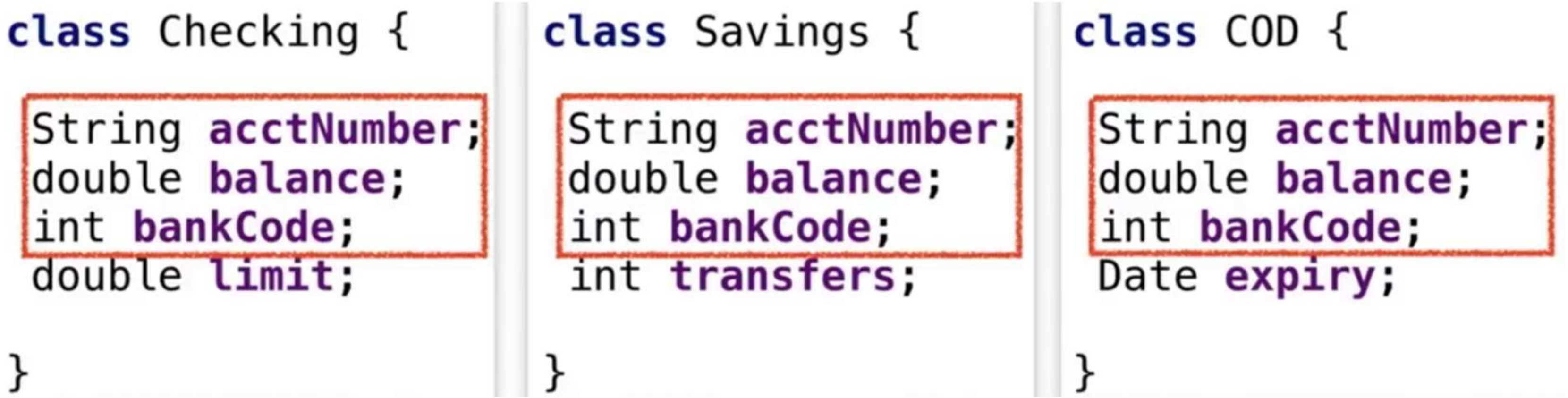
```
class Savings {

 String acctNumber;
 double balance;
 int transfers;

}
```

```
class COD {

 String acctNumber;
 double balance;
 Date expiry;

}
```

Example...

Problem caused by a change!

- If we decide to include **the bank code** ➔ have to change that in **all three classes**



```
class Checking {

String acctNumber;
double balance;
int bankCode;
double limit;

}
```

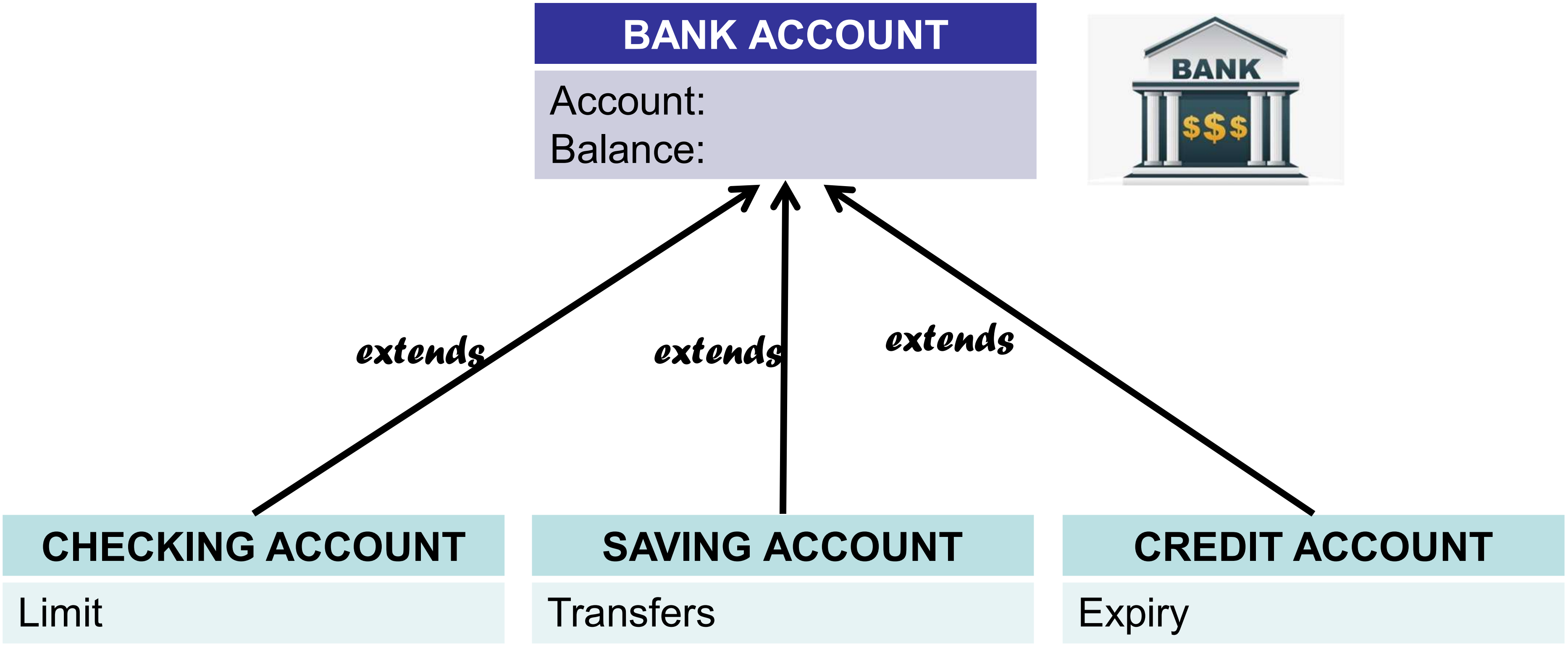
```
class Savings {

String acctNumber;
double balance;
int bankCode;
int transfers;

}
```

```
class COD {

String acctNumber;
double balance;
int bankCode;
Date expiry;

}
```

- This simple change could be **a nightmare** in a production-sized project!

Example...

Inheritance is the solution



BANK ACCOUNT

Account:
Balance:

extends

extends

extends

CHECKING ACCOUNT

Limit

SAVING ACCOUNT

Transfers

CREDIT ACCOUNT

Expiry

Inheritance

- First, start by creating the bank account class

```
class BankAccount{
        String acctNumber;
        double balance;
}
```

- Next, create another class and points to **extend** that basic class by adding the phrase "**extend**" and then the class name

```
class Checking extends BankAccount{
        double limit;
}
```

Inheritance...

```
class BankAccount{
        String acctNumber;
        double balance;
}
```

parent

```
class Checking extends BankAccount{
        double limit;
}
```

child

Inheritance…

```
class SavingAccount extends BankAccount{
        int transfers;
}
```

child

```
class COD extends BankAccount{
        Date expiry;
}
```

child

Conclusion

- From that example, you can see that using **inheritance** has allowed us **to minimize** repeating any code
- While still having **the flexibility** and **the good design** of separate account classes

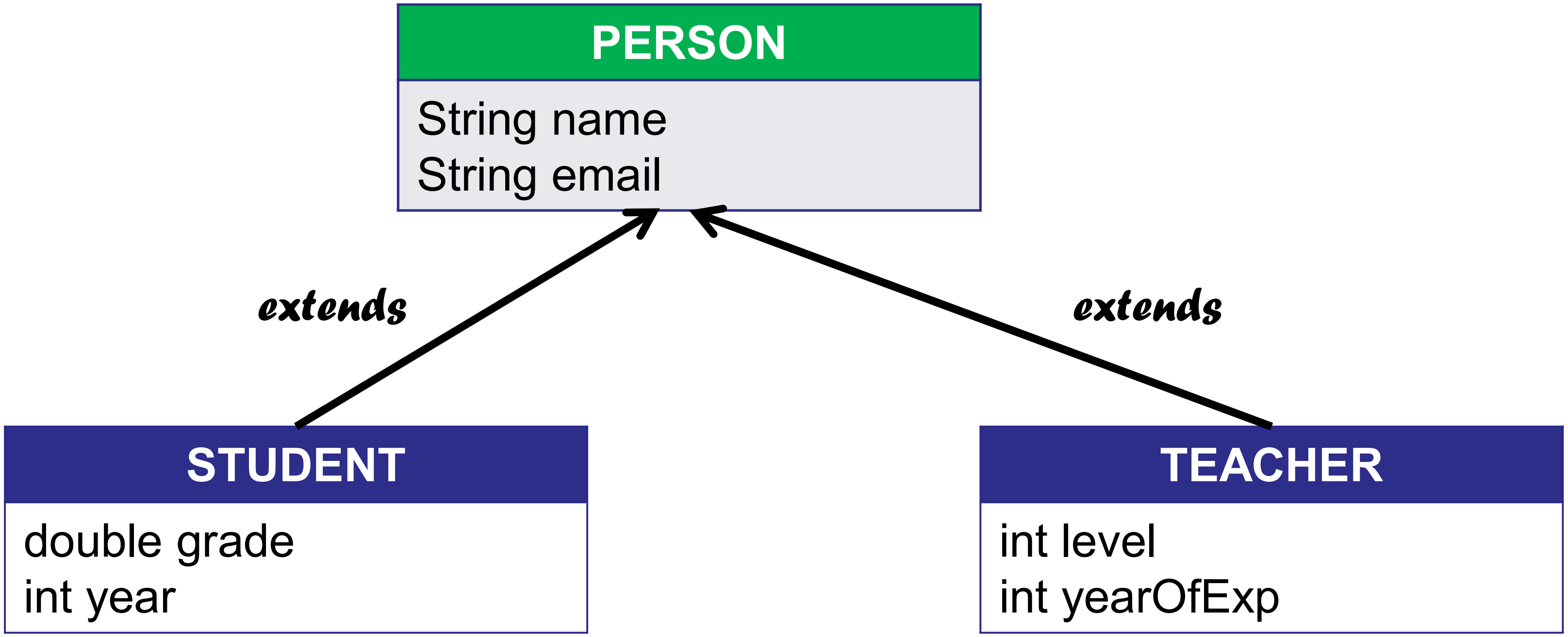
Polymorphism

what is polymorphism?

- **Polymorphism** is something that has **multiple shares** or **forms**

- In object-oriented world, **inheritance** allows **object** to become **polymorphic**
  - Because when an object extends another class, it not only becomes its **own type** but also the t**ype of its parent**

Example

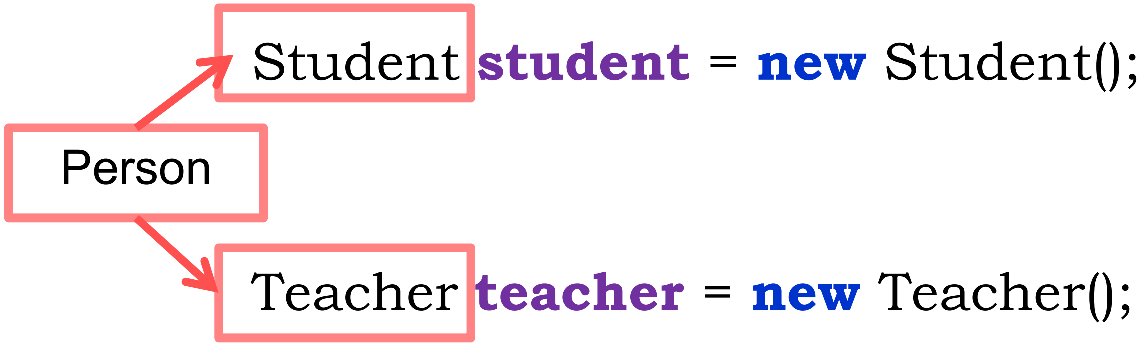

PERSON
String name
String email
extends
extends
STUDENT
double grade
int year
TEACHER
int level
int yearOfExp

Example...

- If you were to create an object of type student, you can start declaring it using the student type and initialize it using the student constructor
  - Student **student** = **new** Student();

- Do similar if you want to create an object of type teacher
  - Teacher **teacher** = **new** Teacher();

Example...



Person

```
Student student = new Student();

Teacher teacher = new Teacher();
```

```
Person student = new Student();

Person teacher = new Teacher();
```

Bags & items example

Coins

int amount
int weight

Crossbow

int power
int weight

RareItem

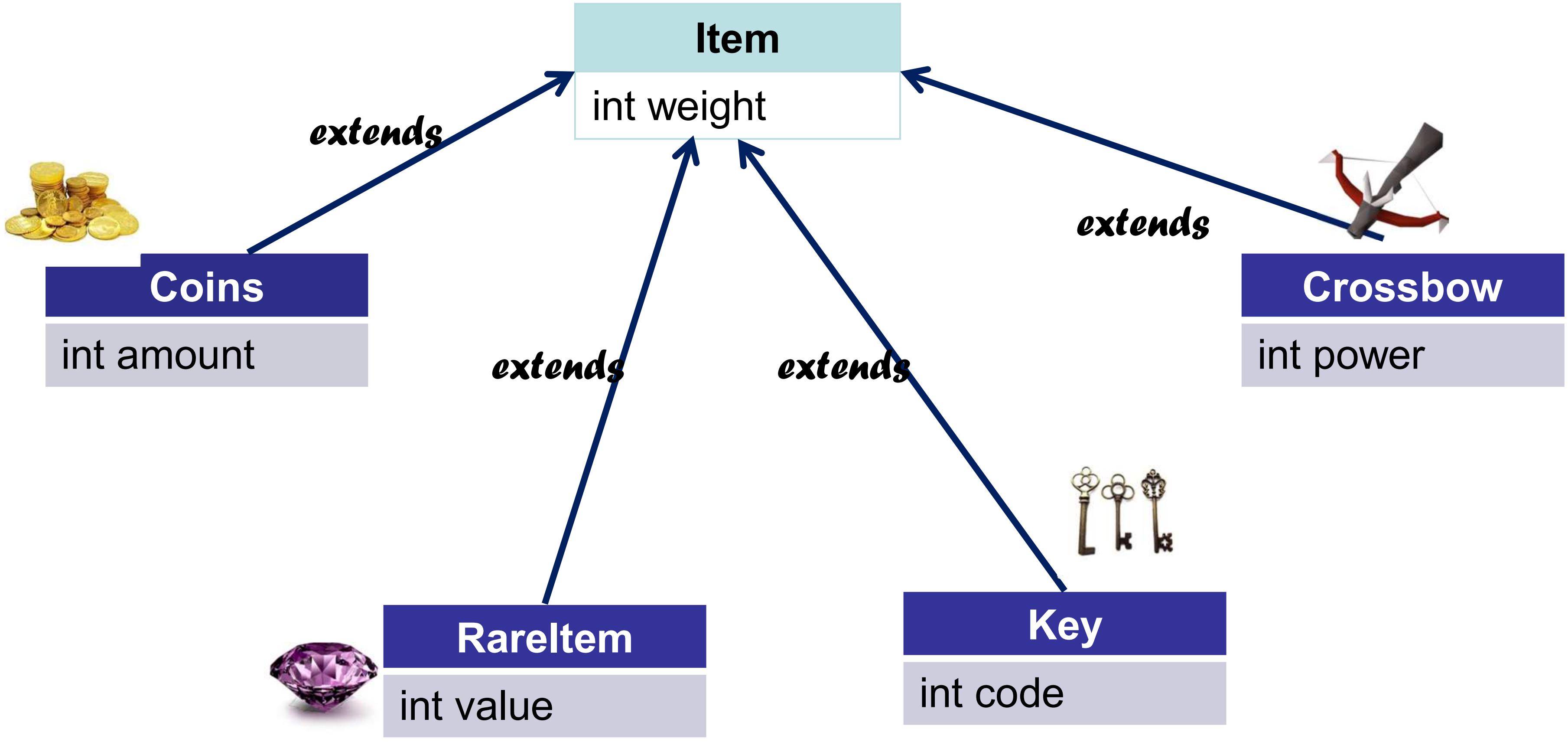
int value
int weight

Key

int code
int weight

Bags & items example

items



Item

int weight

extends

Coins

int amount

extends

RareItem

int value

extends

Key

int code

extends

Crossbow

int power

Bags & items example

Bags

```
public class Bag{
    int currentWeight;
    boolean canAddItem(Item item)
}
```

Bags & items example

Bags...

```
boolean canAddItem(Item item){
    if(currentWeight + item.weight >20)
        return false;
    else
        return true;
}
```

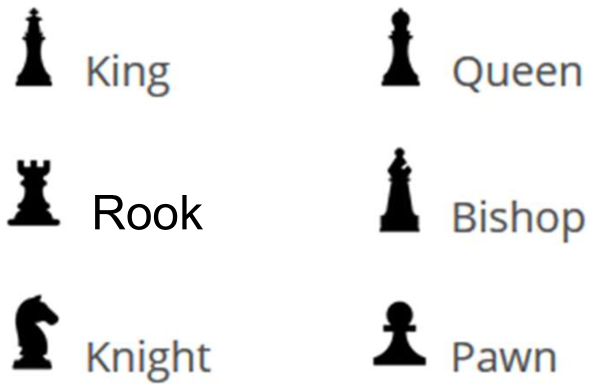
Bags & items example...

```
public static void main(String[] args){
    CrossBow crossbow = new Crossbow();
    if(bag.canAddItem(crossbow)
      bag.addItem(crossbow);//can add crossbow without being casted
}
```

Overriding methods

Chess game example

- A good design in java will have a class for **each piece** of type



  - They should inherit from the base class **Piece**

- **Why?**
  - Because according to the concept of polymorphism, you could represent the **chess-board** as a 2D array of **Piece objects**,
  - and then each cell in the 2D array can **contain** **any of child** classes that **extend** the **Piece class**

Chess game example...

Other classes

- To store **2D array**, we need a class that represents the **Game** itself

```
class Game{
        Piece [][] board;
        Game(){
                board = new Piece[]8[8];
        }
}
```

- Finally, a simple class called **Position** that has nothing more than a row value and a column value to represent a specific slot on the board

```
class Position{
        int row; int column;
        Position(int row, int column){
            this.row=row; this.column=column; }
}
```

Chess game example…

Other classes…

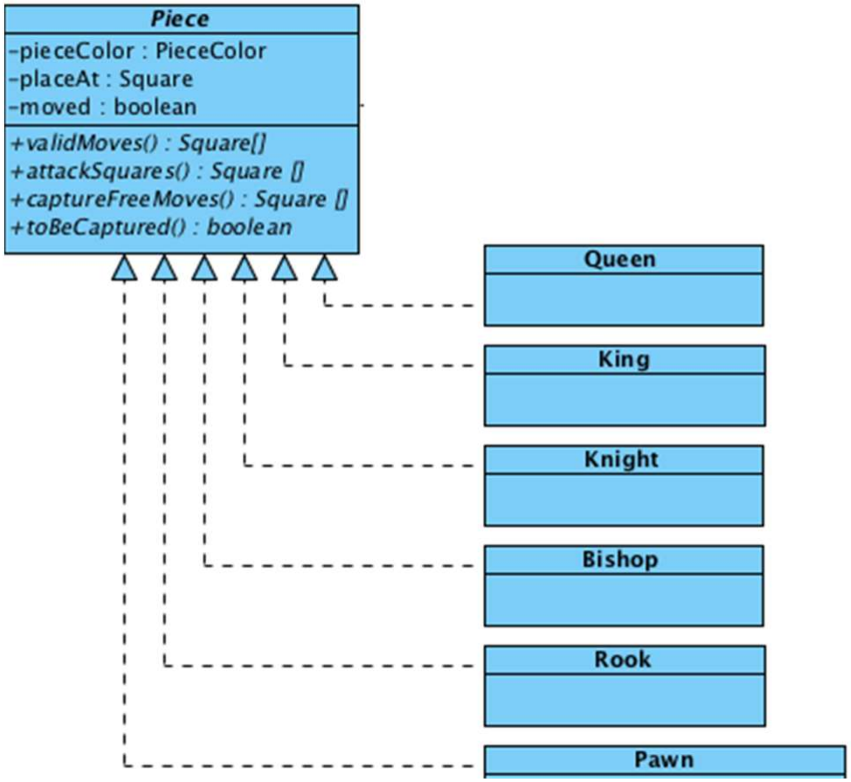
- That way, the **Piece** class can include a field variable of type Position that stores the current position of that piece on the board

```
class Piece{
        Position position;
        ….
}
```

Chess game example...

Other classes...

- Now since all **piece** types inherit from the same parent class Piece, they will all **share** any methods declared in that class
  - e.g., it will be useful to have a method that checks if a potential movement of a piece is valid one
  - A good idea would be to include a method called isValidMove inside the Piece class that take a potential new position and decides if that position is within the bounds of the chess board



Chess game example...

Other classes...

```
class Piece{
        Position position;
        boolean isValidMove(Position newPosition){
            if(newPosition.row > 0 && newPosition.column >0 && newPosition<8 && newPosition.column <8)
                    return true;
            else
                    return false;
        }
}
```

Chess game example...

Other classes...

- Since each of the child class inherits from that Piece class, **each** will automatically include this method, which means you can call it from any of those classes directly

- E.g.,

```
Queen queen = new Queen();
Position testPosition = new Position(3,3);
if(queen.isValidMove(testPosition))
        System.out.println("Yes, you can move there");
else
        System.out.println("Nope, cannot move there");
```

Chess game example…

- Till now, we’re just be able to check the **validity** of the movement of a piece on the board
- **Each piece** type has a **different pattern** of allowed movements, which means that each of those child classes need to implement the isValidMove method **differently**
- Luckily, java not only offers a way **to inherit** a method from a parent class but also **modify** it to build your own custom version of it

Overriding

- When a class **extends** another class, all **public** methods declared in that parent class are automatically included in the child class without doing anything

- However, you are allowed to **override** **any** of those methods

  - Overriding basically means re-declaring them in the child class and then re-defining what they should do

the chess example

- Assume we're implementing the isValidMove method in the **Rook** class
  - the **Rook** class extends the **Piece** class that already includes a definition of the isValidMove method
- The Rook class extends the Piece class that **already includes** a definition of the inValidMove method
- Now, let's implement a **custom version** of that method inside the Rook class

The chess example…

```
class Rook extends Piece{
    boolean isValidMove(Position newPosition){
        if(newPosition.column==this.position.column ||
          newPosition.row==this.position.row)
            return true;
        else
            return false;
    }
}
```

- Notice how **both** method declarations are **identical, except** that the implementation in the **child** class has different code customizing the validity check for the Rook piece

The chess example…

- Basically it’s checking that the **new position** of the rook
  - has the same column value as the current position (which means it’s trying to move up or down)
  - or has the same row position which means it has moved sideways,
  - ← **both** valid movements for a Rook piece
- Remember that this.position.column and this.position.row are the local fields of the **Rook** class holding *the current position of that piece*

The chess example…

- Can do the same for all the other piece types, e.g., the **Bishop** class would have slightly different implementation
- Since Bishop moves diagonally, we want to check that #vertical steps is equal to #horizontal steps.

```
class Bishop extends Piece{
    boolean isValidMove(Position newPosition){
        if(Math.abs(newPosition.column – this.position.column) ==
           Math.abs(newPosition.row- this.position.row))
            return true;
        else
            return false;
    }
}
```

The chess example…

- Now let’s try to override that method for the Queen class
  - **Queen** can move diagonally or in straight lines

- What can we do?
  1. In the Queen class, **override** the isValidMove method
  2. First ,call the parents’ isValidMove to check for the boundaries
  3. Add **more code** to check the queen’s specific move validity

Super

Super?

- Note that once you **override** a method,
  - you basically **ignore everything** that was in the **parent class**

- It's possible not to throw away the parent implementation
  - **ADD** the extra checks for each child class individually

- To **re-use** the parent method in the child class by using the **"super"** keyword, followed by a dot and then the method name
  - **super**.isValidMove(position);

Super…

- That means, in **each** of the child classes,
  - before you get to check the custom movement, you can check if super.isValidMove(position) has returned false
  - If so, then no need to do any more checks and immediately return false
  - otherwise, continue checking
- The new implementation for the Rook class will look like….

example

```
class Rook extends Piece{
    boolean isValidMove(Position newPosition)
    if(!super.isValidMove(position)) //check for the board bounds
        return false;
    //check for the specific rock movement
    if(newPosition.column==this.position.column &&
       newPosition.row==this.position.row)
        return true;
    else
        return false;
}
```

example…

```
class Rook extends Piece{
        //default constructor
        public Rook(){
             super(); //this will call the parent’s constructor
             this.name=“rook”;
        }
}
```

Note: if a child’s constructor doesn’t explicitly call the parent’s constructor using super, the java compiler automatically inserts a call to the *default constructor of the parent* class

If the parent class *doesn’t have a default* constructor, you’ll get a compiler-time error