Media Computation

Lecture 16.1, December 8, 2008

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Today -- Details of Creating Classes

- From requirements to classes
  - Creating a class that will simulate a number game
  - Practice going from requirements to class definitions and fields declarations
  - Random number generators
  - Using an import statement to allow you to use a short name
- Creating Classes
- Hierarchy

Simulating a Number Guess Game

- Have you ever played the pick a number from 1-10 or 1-100 game?
  - One person randomly picks a number in the specified range
  - The other person guesses a number
  - The person who picked the number replies
    - Higher if the guess is too low
    - Lower if the guess is too high
    - Or that is right if the guess is the picked number
      - You could also track the number of guesses

What do we need?

- We need a new class. For each game we will create a new object of this class.
  - It will need to know the minimum number that it can pick from
  - It will need to know the maximum number that it can pick from
  - It will need to pick a number in that range
  - It will need to ask the user for a guess and compare the guess to the picked number
    - And reply higher, lower, or that is right when the guess matches the picked number
  - It will need to keep track of how many guesses have been made

Going from Specifications to a Class

- What should the name of the class be?
  - Class names should be singular
  - Class names should be an indicator of what objects of the class are for or can do
  - Class names start with an uppercase letter and uppercase the first letter of each new word
- Any ideas?

Create the NumberGuessGame Class

- Start by creating a new class in DrJava
  - Select (Untitled) in the Files pane or
  - Click on the “New” button in the menu bar
- Type the following in the definitions pane in DrJava

```
public class NumberGuessGame
{
}
```

- Save it in *NumberGuessGame.java*
- Compile it using the “Compile All” button
  - Which creates *NumberGuessGame.class*

Going from Specifications to Fields

- What fields (state) does each object of the NumberGuessGame need to have?
  - What names should we use for these?
  - What should the types be for the fields?
- Requirements
  - minimum number that it can pick from
  - maximum number that it can pick to
  - Picked number for a game
  - Track how many guesses have been made

Add Field Declarations

- Declaring fields
  - Each field should be private
  - You can assign a value to a field when you declare it
- Each number guess game should have
  - A minimum number

    ```
    private int minNumber = 1;
    ```
  - A maximum number

    ```
    private int maxNumber = 100;
    ```
  - A picked number

    ```
    private int pickedNumber;
    ```
  - A number of guesses so far

    ```
    private int numGuesses = 0;
    ```

Add the Fields

- Edit NumberGuessGame and add the fields

```
public class NumberGuessGame
{
  //////////// fields (data) //////////
  private int minNumber = 1;
  private int maxNumber = 100;
  private int pickedNumber;
  private int numGuesses = 0;
}
```

Picking a Random Number

- There is a class in Java that allows you to pick a pseudo random number
  - java.util.Random
  - You will want to import this class to use the short name

```
import java.util.Random; // before the class definition
```

- You can create an object of this class

```
Random randomNumGen = new Random();
```

- You can get a random number from 0 to one less than a specified integer

```
int randomNum = randomNumGen.nextInt(specifiedInt);
```

Picking from a Min to a Max

- If the Random class returns from 0 to 1 less than a specified integer
  - How do we pick from the minimum to the maximum?
    - No matter what the minimum and maximum are?
  - To pick a number from 1 to 10
    - This is 10 values
      - so pick from 0 to 10 (returns 0 to 9)
      - And add 1 to the result (results in 1 to 10)
  - To pick a number from 11 to 15
    - This is 5 values
      - So pick from 0 to 5 (returns 0 to 4)
      - Add 11 to the result (results in 11 to 15)
  - To pick in any range

```
int numValues = this.maxNumber – this.minNumber + 1;
this.pickedNumber = this.randomNumGen(numValues);
this.pickedNumber = this.pickedNumber + this.minNumber;
```

Add an Import and a Field

- Add the import statement before the class declaration

```
import java.util.Random;
public class NumberGuessGame
```

- Add the new field for the random number generator

```
private int numGuesses = 0;
private Random randomNumGen = new
  Random();
```

Creating Constructors

- Constructors actually initialize the new object
  - Usually set field values for the object
- If the user doesn't specify a min and max number
  - Use the defaults and pick a random number between the min and max
- Add another constructor that let's the user specify the min and max

Declaring Constructors

- To declare a constructor
  - Specify the visibility and the name of the class followed by a parameter list

```
public ClassName(parameterList)
```

- You can declare more than one constructor
  - As long as the parameter lists are different

```
public NumberGuessGame()
public NumberGuessGame(int min, int max)
```

No Argument Constructor

```
/**
 * Constructor that takes no parameters
 * It uses the default min and max
 */
public NumberGuessGame()
{
 int numValues = this.maxNumber - this.minNumber + 1;
 this.pickedNumber =
            this.randomNumGen.nextInt(numValues);
 this.pickedNumber = this.pickedNumber +
                          this.minNumber;
}
```

Constructor with a Min and Max

```
/**
 * Constructor that takes a min and max
 * It uses the passed min and max
 * @param min the minimum number in the range
 * @param max the maximum number in the range
 */
public NumberGuessGame(int min, int max)
{
  this.minNumber = min;
  this.maxNumber = max;
  int numValues = this.maxNumber - this.minNumber + 1;
  this.pickedNumber = this.randomNumGen.nextInt(numValues);
  this.pickedNumber = this.pickedNumber + this.minNumber;
}
```

Summary

- To look for classes
  - Underline nouns
    - Nouns with several pieces of data associated with them are classes
- First determine the classes you will need and create them
- Then determine the data each object of that class will need
  - And declare fields
- The `Random` class in package java.util
  - Can be used to pick a random number
- You can use an import statement
  - To let you use a short name for a class that isn't in java.lang

Today -- Details of Creating Classes

- From requirements to classes
- Methods
  - Pulling out a method
    - That is called by the constructors
  - Getting input
    - Using SimpleInput class from Georgia Tech
  - Showing output
    - Using SimpleOutput class from Georgia Tech
  - Generating random sentences
- Hierarchy

Pull out a Method

- Both Constructors need to pick a random number using the minimum and maximum
- We can pull out this common code and make a method for it

```
public void pickNumber()
```

- And then call the method in each constructor

Pick a Number Method

```
public NumberGuessGame(int min, int max)
 {
  this.minNumber = min;
  this.maxNumber = max;
  this.pickNumber();
 }

public void pickNumber()
 {
  int numValues = this.maxNumber - this.minNumber + 1;
  this.pickedNumber = this.randomNumGen.nextInt(numValues);
  this.pickedNumber = this.pickedNumber + this.minNumber;
 }
```

Need a Method to Play the Game

- Set a variable to not done
- Loop while not done
  - Get the current guess
  - Increment the number of guesses
  - Check if the guess was right
    - If so tell the user the guess was right and how many guesses it took
    - Set a variable (done) to stop the loop
  - Check if the guess was low
    - Tell the user
  - Else the guess was too high
    - Tell the user

Need a Way to Interact with User

- Use the `SimpleInput` class for input
  - Created by Georgia Tech
  - Has a method `getIntNumber(String message)`
    - That will display the message in a pop-up window and return an integer number entered by the user
- Use the `SimpleOutput` class for output
  - Created by Georgia Tech
  - Has a method `showInformation(String message)` which will display the output in a pop-up window
    - And wait for the user to push a button to show it has been read

Going from Algorithm to Code

- Set a variable to not done
- Loop while not done
  - Get the current guess
  - Increment the number of guesses
  - Check if the guess was right
    - If so tell the user the guess was right and how many guesses it took
    - Set a variable (done) to stop the loop
  - Else check if the guess was low
    - Tell the user
  - Else the guess was too high
    - Tell the user

Use boolean done variable and set it to false

Use a while loop that loops as long as the done isn't true

`while (!done)`

Using `SimpleInput`

And a variable guess

`numGuesses++;`

`if (guess == pickedNumber)`

Use `SimpleOutput` and `numGuesses`

Change `done` to `true`

`else if (guess < pickedNumber)`

`else`

Add a method to play the game

```
public void playGame()
 {
   boolean done = false;

   // loop till guess is correct
   while (!done)
   {
    // need to get a guess from the user
    int guess = SimpleInput.getIntNumber("Pick a number "+
                                "between " + this.minNumber + " and " +
                                this.maxNumber);

    // increment the number of guesses
    this.numGuesses++;

    // we need to check the guess (compare to pickedNum)
    if (guess == this.pickedNumber)
    {
```

Based on slides by Barb Ericson,
Georgia Institute of Technology

Play

```
     // tell the user she/he was right
     SimpleOutput.showInformation("That was right! " +
                           "It took you " +
                           this.numGuesses + " tries");
     done = true;
    }
    else if (guess < this.pickedNumber)
    {
     // we need to tell the user too low
     SimpleOutput.showInformation("Too low");
    }
    else
    {
     // tell the user the guess is too high
     SimpleOutput.showInformation("Too high");
    }
   }
  }
```

Add a main method

```
public static void main(String[] args)
{
 NumberGuessGame game = new NumberGuessGame();
 game.playGame();
}
```

Random Sentence Generator Exercise

- Write a class that can generate random sentences.
  - Create a class `SentenceGenerator`
    - That has an array of nouns
    - An array of verbs
    - And an array of phrases
    - And a method generate sentence which will return a String object that has a randomly selected noun, verb, and phrase appended together

Summary

- If more than one constructor needs to do the same thing
  - Pull out the common thing and put it in a method
  - And call the method in the constructors
- You can get input from the user
  - Using SimpleInput
- You can display output to the user
  - Using SimpleOutput
- You can use java.util.Random
  - To create random sentences

Today -- Painful Details of Classes

- From requirements to classes
- Methods
- Hierarchy
  - Inheriting from a class
  - The implicit call to super()
  - Calling parent constructors explicitly
  - Overriding a parent method
  - How methods invocations are resolved

Creating an Inherited Class

- Create a class `ConfusedTurtle` that inherits from the ***Turtle*** class
  - But when a `ConfusedTurtle` object is asked to turn left, it should turn right
  - And when a `ConfusedTurtle` object is asked to turn right, it should turn left

Inheriting from a Class

- To inherit from another class
  - Add extends ClassName to the class declaration

```
public class ConfusedTurtle extends Turtle
{
}
```

- Save in ConfusedTurtle.java
- Try to compile it

Compile Error?

- If you try to compile `ConfusedTurtle` you will get a compiler error
  - Error: cannot resolve symbol
  - symbol: constructor Turtle()
  - location: class Turtle
- Why do you get this error?

PAINFUL DETAIL ALERT

Inherited Constructors

- When one class inherits from another all constructors in the child class will have an implicit call to the no-argument parent constructor as the first line of code in the child constructor
  - Unless an explicit call to a parent constructor is there as the first line of code
    - Using super(paramList);

PAINFUL DETAIL ALERT

Why is an Implicit Call to Super Added?

- Fields are inherited from a parent class
  - –But fields should be declared private
    - Not public, protected, or package visibility
      - –Lose control over field at the class level then
  - –But then subclasses can't access fields directly
  - –How do you initialize inherited fields?
    - By calling the parent constructor that initializes them
      - –Using super(paramList);

PAINFUL DETAIL ALERT

Explanation of the Compile Error

- There are no constructors in `ConfusedTurtle`
  - So a no-argument one is added for you
    - With a call to super();
  - But, the `Turtle` class doesn't have a no-argument constructor
    - All constructors take a ***world*** to put the ***turtle*** in
- So we need to add a constructor to `ConfusedTurtle`
  - That takes a world to add the turtle to
    - And call `super(theWorld);`

Add a Constructor that takes a World

```
public class ConfusedTurtle extends Turtle
{
 /**
  * Constructor that takes a world and
  * calls the parent constructor
  * @param theWorld the world to put the
  * confused turtle in
  */
 public ConfusedTurtle(World theWorld)
 {
  super (theWorld);
 }

}
```

PAINFUL DETAIL ALERT

Add a Constructor that takes a World

```
public class ConfusedTurtle extends Turtle
{
 /**
  * Constructor that takes a world and
  * calls the parent constructor
  * @param modelDisplayObj the world to put the
  * confused turtle in
  */
 public ConfusedTurtle(ModelDisplay modelDisplayObj)
 {
  super (modelDisplayObj);
 }

}
```

In the book, it goes one more level up the hierarchy from Turtle to SimpleTurtle whose instance variable is the super class of World, called "ModelDisplay".

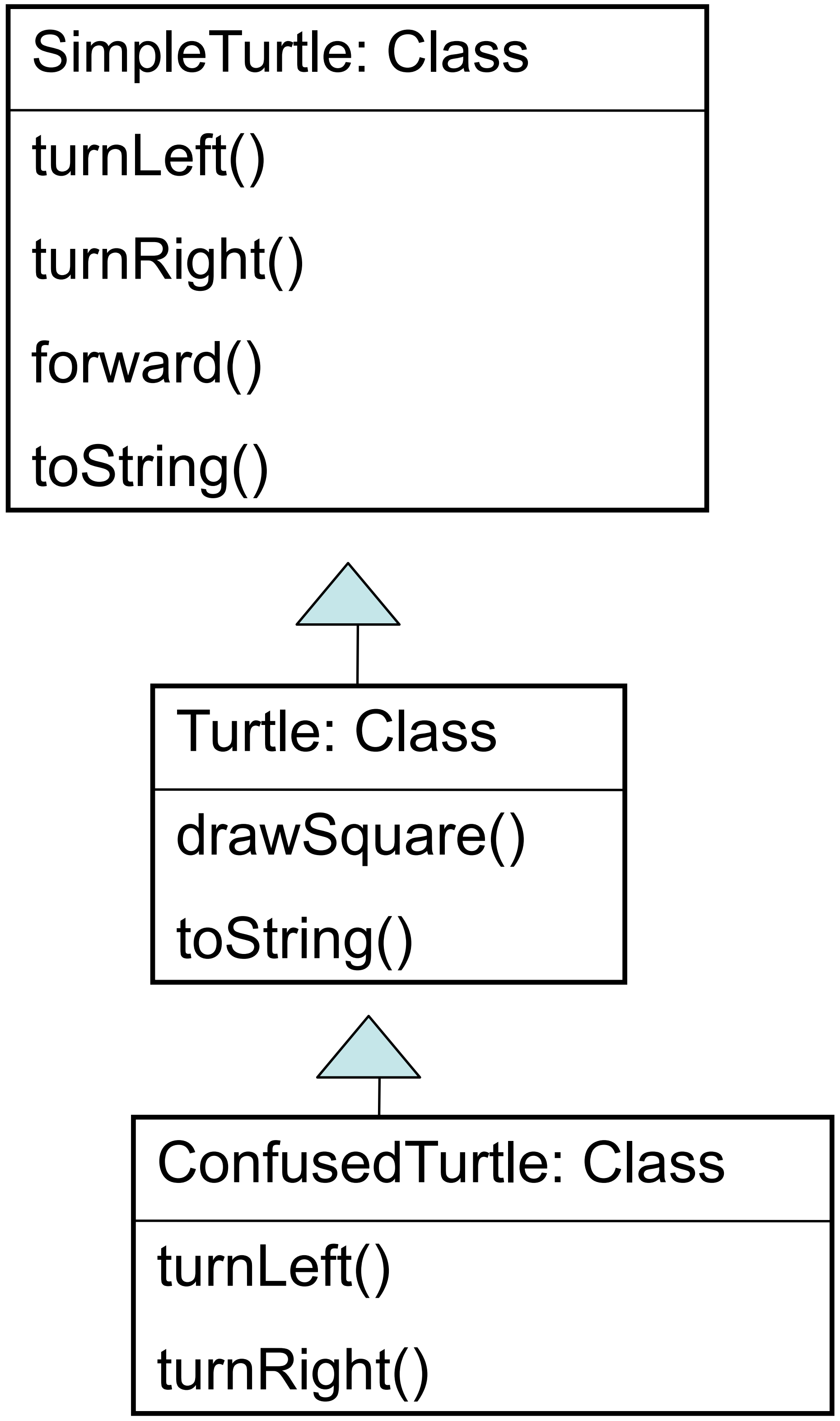
Try this Out

- Compile ConfusedTurtle
  - It should compile
- Try it out
  - It should act just like a Turtle object
- How do we get it to turn left when asked to turn right?
  - And right when asked to turn left?
    - Use super.turnLeft() and super.turnRight()
      - super is a keyword that means the parent class

What would happen if we used “this.turnLeft()” instead of “super.turnLeft()” ?

Resolving Methods

- When a method is invoked (called) on an object
  - The class that created the object is checked
    - To see if it has the method defined in it
      - If so it is executed
      - Else the parent of the class that created the object is checked for the method
      - And so on until the method is found
- Super means start checking with the parent of the class that created the object



Polymorphism

- Means many forms
- Allows for processing of an object based on the object's type
- A method can be declared in a parent class
  - And redefined (overriden) by the subclasses
- Dynamic or run-time binding will make sure the correct method gets run
  - Based on the type of object it was called on at run time

Confused Turtle turnLeft and turnRight

```
/**
  * Method to turn left (but confused turtles
  * turn right)
  */
 public void turnLeft()
 {
  super.turnRight();
 }

 /**
  * Method to turn right (but confused turtles
  * turn left)
  */
 public void turnRight()
 {
  super.turnLeft();
 }
```

Try out ConfusedTurtle

```
> World earth = new World();
> Turtle tommy = new Turtle(earth);
> tommy.forward();
> tommy.turnLeft();
> ConfusedTurtle bruce = new ConfusedTurtle(earth);
> bruce.backward();
> bruce.turnLeft();
> bruce.forward();
> tommy.forward();
> tommy.turnRight();
> bruce.turnRight();
```

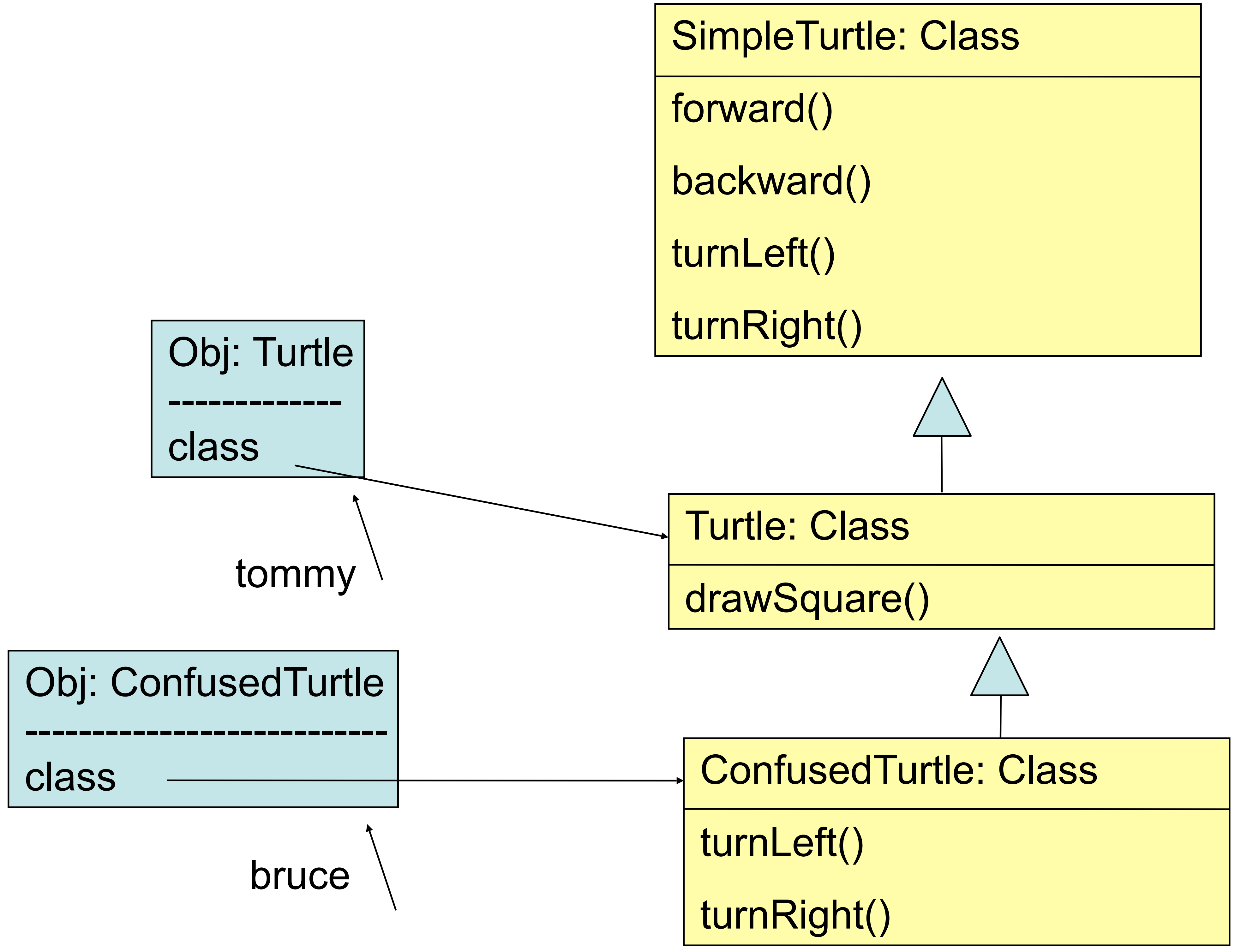
Override Methods

- Children classes inherit parent methods
  - The confused turtle knows how to go forward and backward
    - Because it inherits these from `Turtle`
- Children can override parent methods
  - Have a method with the same name and parameter list as a parent method
    - This method will be called instead of the parent method
      - Like `turnLeft` and `turnRight`

What is Happening?

- Each time an object is asked to execute a method
  - It first checks the class that created the object to see if the method is defined in that class
    - If it is it will execute that method
    - If it isn’t, it will next check the parent class of the class that created it
      - And execute that method if one if found
      - If no method with that name and parameter list is found it will check that classes parent
        - » And keep going till it finds the method

Method Overloading



Exercises

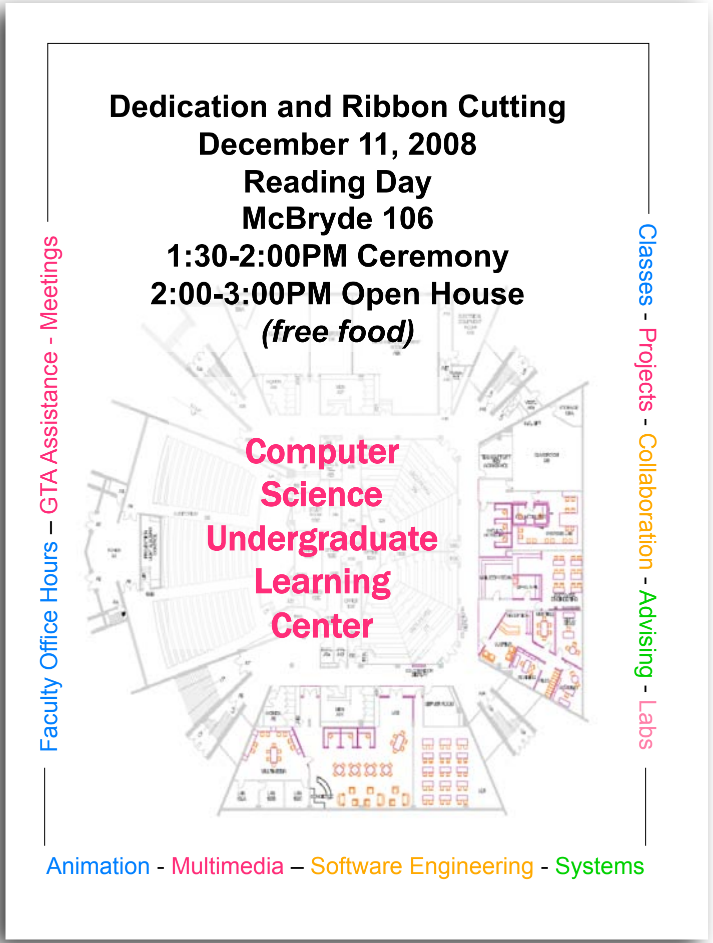
- Create a `DizzyTurtle` class
  - That turns a bit to the left and goes forward when asked to go forward
  - And turns a bit to the right and goes backward when asked to go backward
- Create a `SlowTurtle` class
  - That only goes forward and backward by 50 instead of 100 if you don't tell it how much to go forward or backward
- Create a `StubbornTurtle` class
  - Has a 50% chance of doing what you ask

Summary

- Use the `extends` keyword to specify the parent class
  - When you declare a class
    public class ConfusedTurtle **extends** Turtle
- A class inherits methods and fields from a parent class
  - But doesn't have direct access to private fields and methods
- A implicit call to the no-arg parent constructor will be added
  - If there isn't a call to super(paramList) as the first line of code in a child constructor
- A class can override a parent method
  - To be called instead of the parent method
    - Using the same method name and parameter list as a parent method
- A method can invoked a parent's method
  - Using super.methodName(paramList);

Coming Attractions

- HW 10 - oche
  - –due on Thursday
  - –look at Python echo recipe
    - what is different?
- Wednesday
  - –review for Final
  - –take home announced
- Thursday (2-3 PM) in 110 McB
  - –Open House
  - –Learn about game design, animation, multimedia, cyberart
  - –FOOD !



Dedication and Ribbon Cutting
December 11, 2008
Reading Day
McBryde 106
1:30-2:00PM Ceremony
2:00-3:00PM Open House
(free food)

Computer Science Undergraduate Learning Center

Faculty Office Hours – GTA Assistance - Meetings

Classes - Projects - Collaboration - Advising - Labs

Animation - Multimedia – Software Engineering - Systems