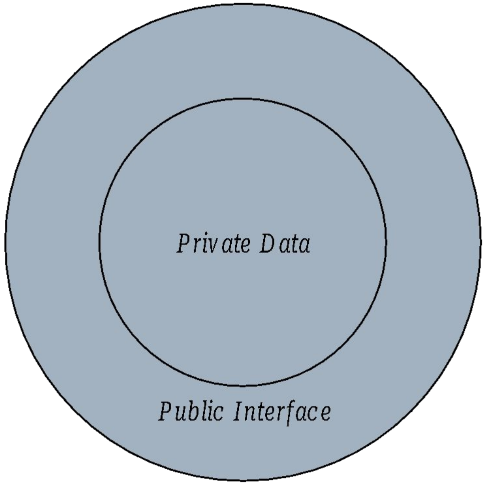
Properties of OOP

SE 206

Encapsulation

- The data (state) of an object is private – it cannot be accessed directly.
- The state can only be changed through its public *interface*.
- This is called *encapsulation*

"The Doughnut Diagram" Showing that an object has private state and public behaviour. State can only be changed by invoking some behaviour



Classes

Preparation

- Scene so far has been background material and experience
  - Variables
  - Data Types
  - Input and output
  - Expressions
  - Assignments
  - Objects
  - Standard classes and methods
  - Decisions (if, switch)
  - Loops (while, for, do-while)

- Now: Experience what Java is really about
  - Design and implement objects representing information and physical world objects

Object-oriented programming

- Basis
  - Create and manipulate objects with attributes and methods that the programmer can specify
- Mechanism
  - Classes
- Benefits
  - An information type is designed and implemented once
    - Reused as needed
      - No need reanalysis and re-justification of the representation

Known Classes

- Classes we’ve seen
  - String
  - Scanner
  - System

The Car class

A new example: creating a Car class

- □ What properties does a car have in the real world?
  - Color
  - Position (x,y)
  - Fuel in tank

- □ We will implement these properties in our Car class

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Car’s instance variables

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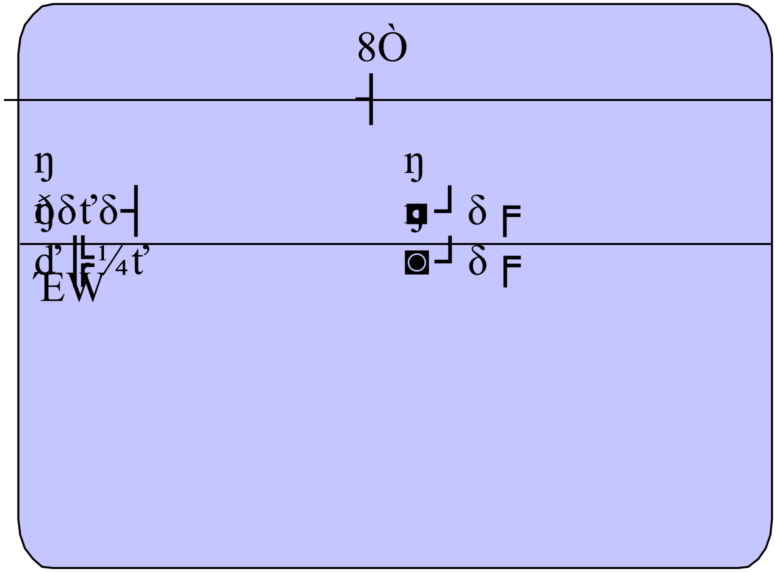

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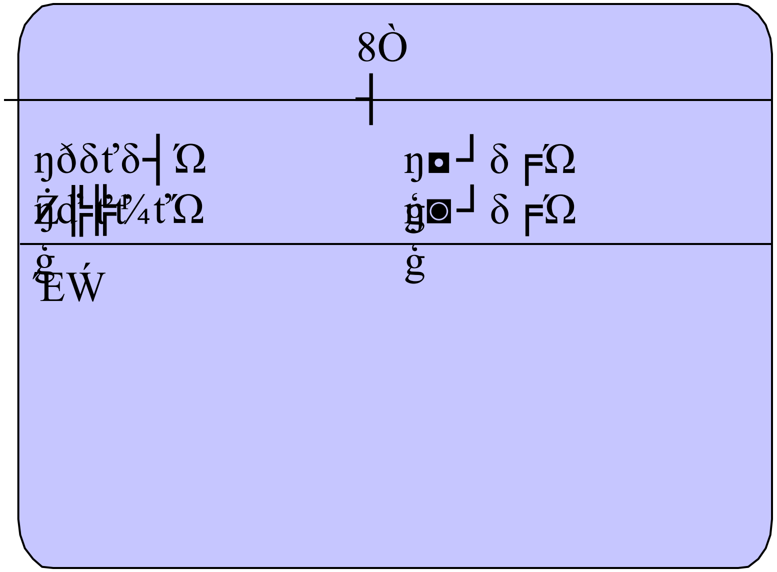
Instance variables and attributes

- □ Default initialization
  - ■ If the variable is within a method, Java does NOT initialize it
  - ■ If the variable is within a class, Java initializes it as follows:
    - □ Numeric instance variables initialized to 0
    - □ Logical instance variables initialized to false
    - □ Object instance variables initialized to null



Car behaviors or methods

- What can a car do? And what can you do to a car?
  - Move it
    - Change it's x and y positions
  - Change it's color
  - Fill it up with fuel

- For our computer simulation, what else do we want the Car class to do?
  - Create a new Car
  - Change Car's condition
- Each of these behaviors will be written as a method

Creating a new car

- □ To create a new Car, we call:
  - ■ Car car = new $\boxed{\text{Car();}}$
- □ Notice this looks like a method
  - ■ You are calling a special method called a constructor
  - ■ A constructor is used to create (or construct) an object
    - □ It sets the instance variables to initial values
- □ The constructor:

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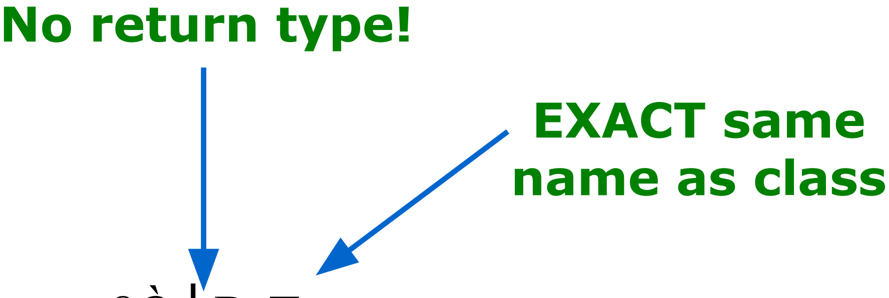
Constructors



No return type!

EXACT same name as class

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Our Car class so far

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Our Car class so far

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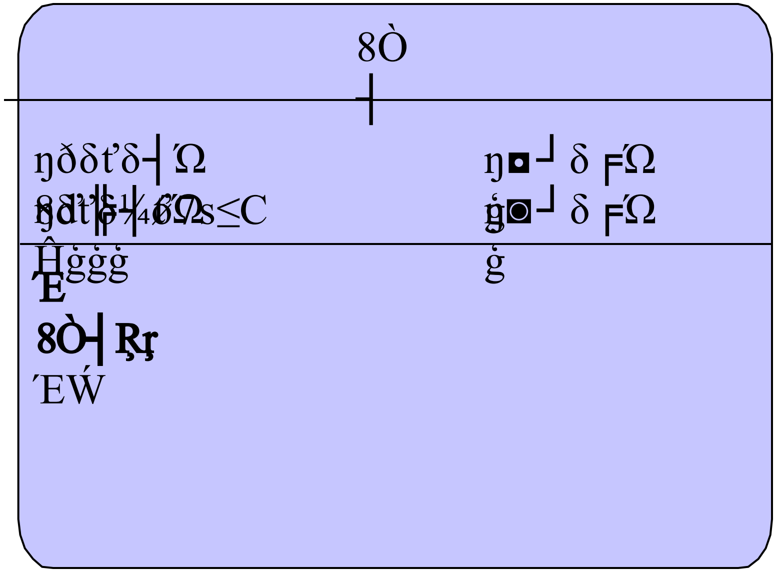

- □ Called the default constructor
  - ■ The default constructor has no parameters
  - ■ If you don’t include one, Java will SOMETIMES put one there automatically

Another constructor

- Another constructor:

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- This constructor takes in four parameters
- The instance variables in the object are set to those parameters
- This is called a specific constructor
  - An constructor you provide that takes in parameters is called a specific constructor

Our Car class so far

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     8Ò┤ Ŗ8δtʼδ┤ ð·l·Ż╚◘·l·Ż╚◙·l·Ż╚ďŗŦ
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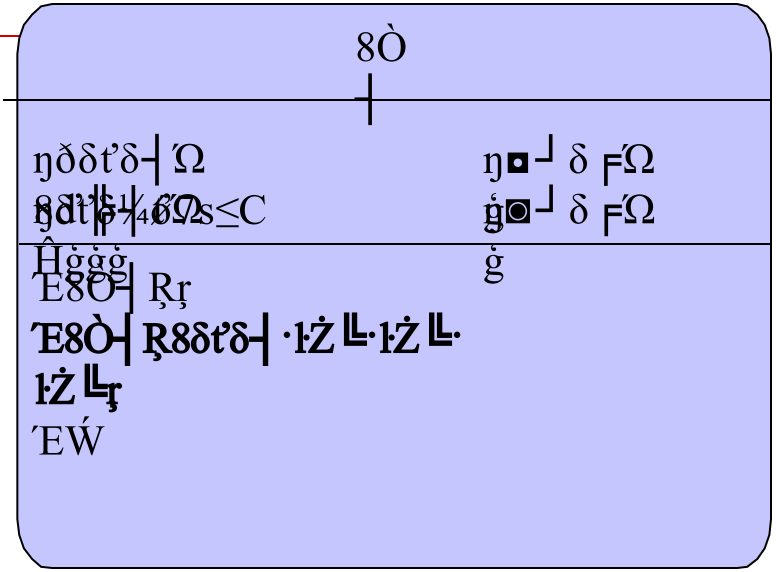

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Using our Car class

- □ Now we can use both our constructors:

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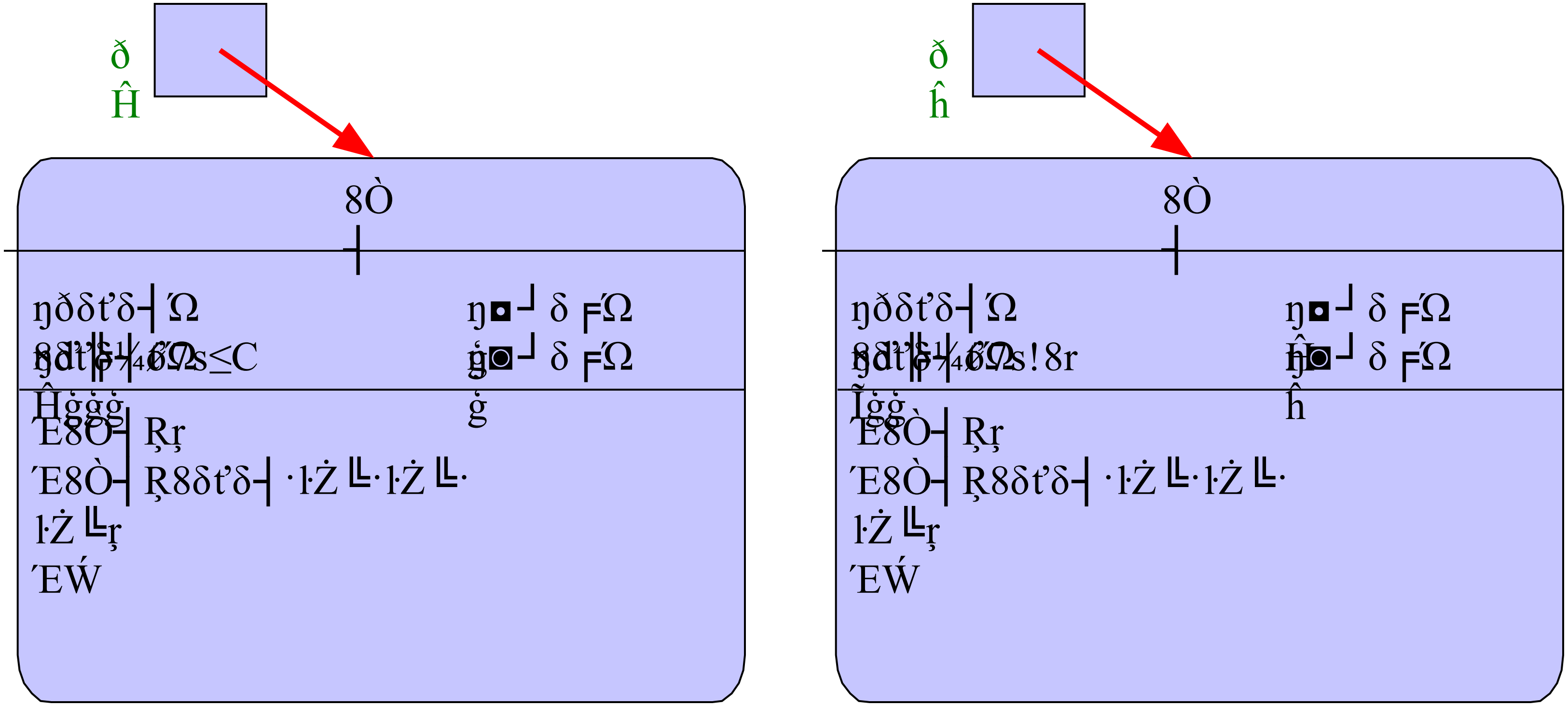

So what does private mean?

Note that it’s a different class!

- Consider the following code

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- Recall that fuel is a private instance variable in the Car class
- Private means that code outside the class CANNOT access the variable
  - For either reading or writing
- Java will not compile the above code
  - If fuel were public, the above code would work

So how do we get the fuel of a Car?

- □ Via accessor methods in the Car class:

```
┘ ╠Ðť'l·ðl·Ż ╚Ð¼ ╚W ╠¼ť'ŖŗŦ
    ┤ ¼ ╚ ╠┤ Żď' ╠¼ť'ẁ
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┘ ╠Ðť'l·ð8δť'δ┤ Ð¼ ╚8δť'δ┤ ŖŗŦ
┤ ¼ ╚ ╠┤ Żðδť'δ┤ ẁ
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┘ ╠Ðť'l·ðl·Ż ╚Ð¼ ╚–ùδ ╒ŖŗŦ
┤ ¼ ╚ ╠┤ Ż◙┘ δ ╒ẁ
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┘ ╠Ðť'l·ðl·Ż ╚Ð¼ ╚œùδ ╒ŖŗŦ
    ┤ ¼ ╚ ╠┤ Ż◘┘ δ ╒ẁ
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- □ As these methods are within the Car class, they can read the private instance variables
- □ As the methods are public, anybody can call them

So how do we set the fuel of a Car?

□ Via mutator methods in the Car class:

```
┘ ╟Ðt’l·ð▬δl·¹ ╒¼ ╚W ╟¼t’Ŗl·Ż ╚d’ŗŦ
      d’ ╟¼t”Ωd’ẁ
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┘ ╟Ðt’l·ð▬δl·¹ ╒¼ ╚8δt’δ┤ Ŗ8δt’δ┤ ðŗŦ
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┘ ╟Ðt’l·ð▬δl·¹ ╒¼ ╚œùδ ╒Ŗl·Ż ╚◘ ŗŦ
◘┘ δ ╒Ώ◘ ẁ
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┘ ╟Ðt’l·ð▬δl·¹ ╒¼ ╚–ùδ ╒Ŗl·Ż ╚◙ ŗŦ
◙┘ δ ╒Ώ◙ ẁ
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```

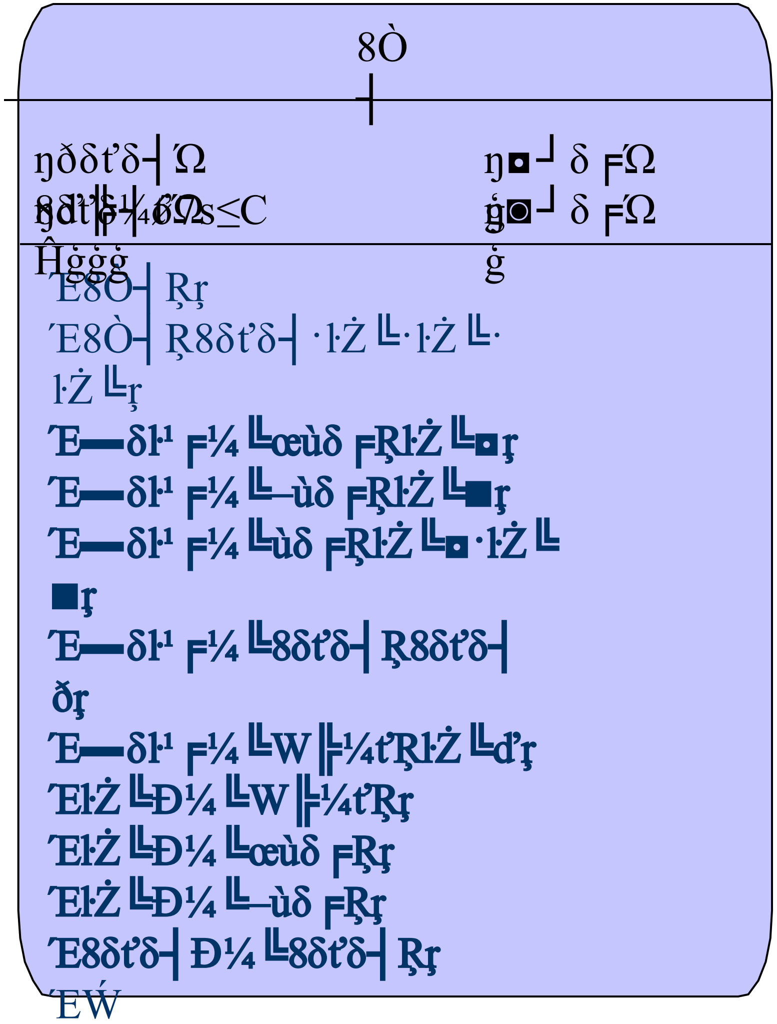
□ As these methods are within the Car class, they can read the private instance variables

□ As the methods are public, anybody can call them

Why use all this?

- □ These methods are called a get/set pair
  - ■ Used with private variables

- □ Our Car so far:



Back to our specific constructor

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    ┘┤ŀ▬Ò╙¼ŀŻ ╙◙┘ δ ╒Ώģẁ
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        ╒¼ ╙8δťδ┤ Ŗðŗẁ
        ╒¼ ╙œùδ ╒Ŗ◘ŗẁ
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Back to our specific constructor

- Using the mutator methods (i.e. the ‘set’ methods) is the preferred way to modify instance variables in a constructor

So what’s left to add to our Car class?

- What else we should add:
  - A mutator that sets both the x and y positions at the same time
  - A means to “use” the Car’s fuel

- Let’s do the first:

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┘ ╠Ðtľl·ð▬δl·¹ ╒¼ ╚ùδ ╒Ŗl·Ż ╚◘ ·l·Ż ╚◙ŗŦ
      ╒¼ ╚œùδ ╒Ŗ◘ŗẁ
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```

- Notice that it calls the mutator methods

Using the Car’s fuel

- Whenever the Car moves, it should burn some of the fuel
  - For each pixel it moves, it uses one unit of fuel
    - We could make this more realistic, but this is simpler

```
┘ ╟Ðťŀð▬δŀ¹ ╒¼ ╙œùδ ╒ŖŀŻ ╙◘ŗŦ
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Using the Car’s fuel

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□ Notice that to access the instance variables, the accessor methods are used

□ Math.abs() gets the absolute value of the passed parameter

The main() method

- □ Consider a class with many methods:

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- □ Where does Java start executing the program?
  - ■ Always at the beginning of the main() method!

Running a class without a main() method

- Consider the Car class
  - It had no main() method!
  - Create another class named “CarSimulation” where main function and Car class is declared.

- So let’s try running it…