Java Foundations

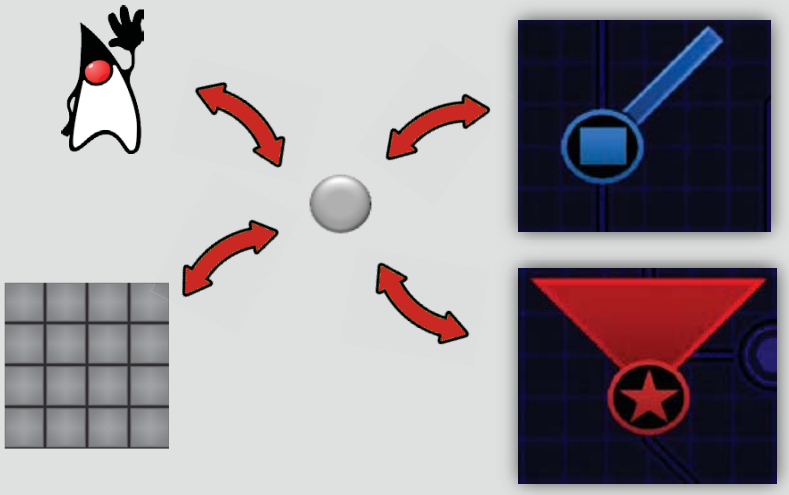
Object Interaction and Encapsulation

Objectives

- This lesson covers the following objectives:
  - Understand object interaction in greater detail
  - Use the private modifier to define class variables
  - Understand the purpose of getter methods
  - Understand the purpose of setter methods

Object Interaction

- Section 2 introduced the idea of object interaction
  - No prescribed sequence for how object must interact
- This lesson explores how to program interactions



What Is Object Interaction?

- An object reference is a memory address
  - A reference directs one object to another
  - A reference allows one object to interact with another
- Objects interact by …
  - Accessing another object's fields
  - Calling another object's methods
- If the main method instantiates every object …
  - The main method contains every object reference
  - The main method can access every objects' fields and methods

Example Program

- Consider a program that models Prisoner, Cell, and Guard objects
- The main method may look like this:

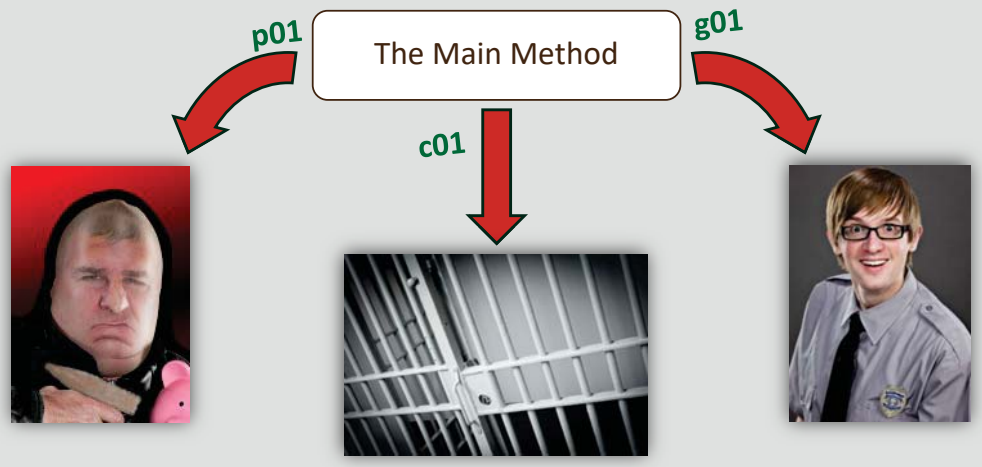
```
public class PrisonTest{
   public static void main(String[] args){
      Prison p01 = new Prisoner();
      Cell   c01 = new Cell();
      Guard  g01 = new Guard();

      p01.name = "Bubba";
      c01.name = "A1";
      g01.name = "Boss Man";
   }//end method main
}//end class PrisonTest
```

Object references

Interactions

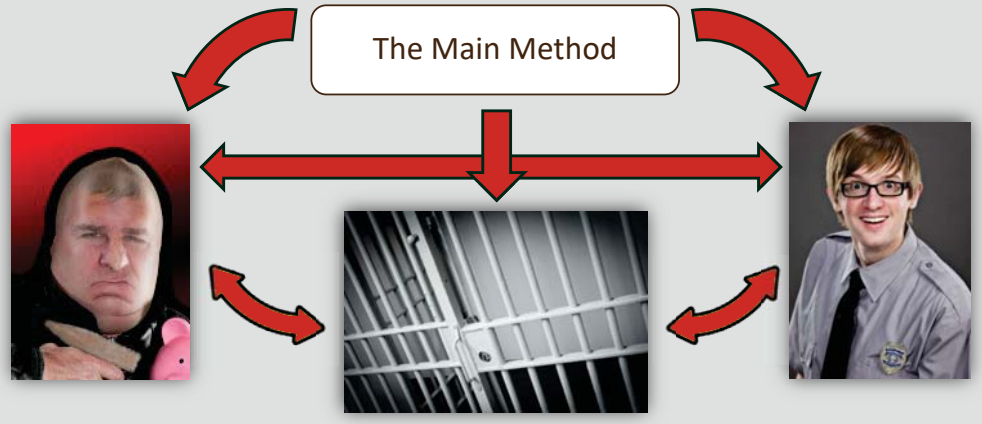
Interactions from the Main Method

- The main method contains all the object references
- Therefore, the main method controls all interactions in this system



Interactions Between Objects

- However, sometimes you'll want a program where objects interact with each other
- To do this, objects must know about each other
  - One object must know a reference to the other object



How Do Objects Know About Each Other?

- Object references must be shared:
  - One object may contain another object as a field
  - One object's method may accept another object as an argument
- For example:
  - A way to describe a Prisoner is by their Cell number
  - It could be argued that a Cell is a property of a Prisoner object
  - The Prisoner class would contain a Cell field

Exercise 1, Part 1

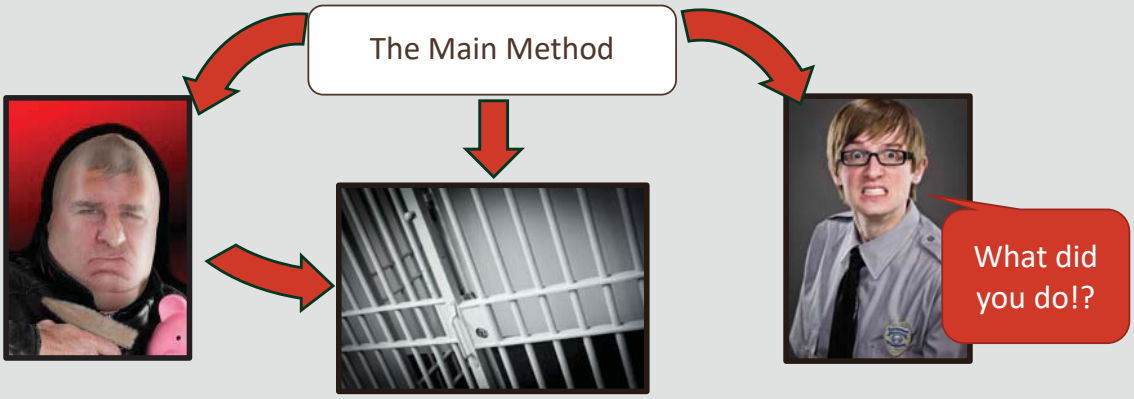
- Continue editing the `PrisonTest` project
  - A version of this program is provided for you
- Create a Cell class that includes the following:
  - String name of the cell
  - Boolean describing whether the door is open
  - Two-argument constructor that sets both fields
- Modify the Prisoner class so that it:
  - Includes a Cell field
  - Sets the Cell field based on a constructor parameter
  - Prints the cell's name as part of the display() method

Exercise 1, Part 2

- Write an openDoor() method in the `Prisoner` class
  - Access and modify the corresponding field in the Cell object so that:
    - If the door is closed, open it
    - If the door is open, close it
  - Print whether the door opens or closes
- From the main method:
  - Instantiate a Cell and a Prisoner object
  - Call the prisoner's display() method once
  - Call the openDoor() method a few times

Oops!

- The guards are panicking!
- Your program allows prisoners to access their cell doors
- Considering Bubba's plans for revenge, this type of interaction should not be allowed!



Think About Potential Object Interactions

- Consider which objects must know about each other
  - Some objects have no business modifying another's fields
  - Try to minimize their knowledge of each other …
  - This prevents unwanted results and make code less complicated
- Consider which direction the interactions might occur and which objects should be properties of each other
  - Should a Prisoner have a Cell property?
  - Should a Cell have a Prisoner property?
  - Or should neither know about each other?

Think About How to Distribute Behaviors

- Cells are designed to open and close
  - Someone must have access to perform these interactions
  - Prisoners should not be capable of this behavior
  - Guards should be capable of this behavior
- Deciding how to distribute behaviors between objects is an important challenge of object-oriented programming
  - But don't worry. You already have experience doing this
  - A major goal of Java Puzzle Ball was to create situations where players needed to think carefully about distributing behaviors between different object types

Introducing Encapsulation

- Sometimes objects must know about each other
- Encapsulation provides techniques for limiting one class's visibility of another
- It's possible to restrict which fields and methods other classes can see
- Special methods can be written to decide how data should be accessed and modified
- Access and visibility should be limited as much as possible

Access Modifiers

- The public keyword is one of several access modifiers
- Access modifiers limit the visibility of fields and methods between classes

```
public class Cell {
   //Fields
   public String name;
   public boolean isOpen ;

   //Constructor
   public Cell(String name, boolean isOpen){
      this.name = name;
      this.isOpen = isOpen;
   }//end constructor
}//end class Cell
```

Access Modifier Details

- public: Visible to any class
  - It's the least secure
  - Methods are typically public
- Package: Visible to the current package
  - There's no keyword for this level of access
- private: Visible only to the current class
  - It's the most secure
  - Fields are typically private

Exercise 2

- Continue editing the `PrisonTest` project
- Modify the `Cell` class:
  - Change its fields to private
  - Save the file
- Does NetBeans have any complaints?
  - What are the complaints?
  - Where do they occur?

The Effects of Private Data

- The following private fields can't be accessed outside the Cell class:
  - isOpen
  - name
- Even the main method can't access this data
- It's good that prisoners can't open their cell doors
- It's bad that prisoners don't know the names of their cells
  - The next topic discusses how to address this issue

Introducing Getter Methods

- When a field is inaccessible, it can't be:
  - Read
  - Modified
- However, in many cases it's desirable for one class to at least know the value of another class's fields
  - A prisoner should at least know their cell name
  - This requires a prisoner to read the value of a Cell's name field
- Getter methods provide a solution

Getter Methods

- Getters are also called accessors
- Getters are public
- Getters usually accept no arguments
- Getters return the value of a particular variable
  - Most private variables require a getter method

```
public class Cell {
   …
   public String getName(){
      return name;
   }//end method getName
   public boolean getIsOpen(){
      return isOpen;
   }//end method getIsOpen
}//end class Cell
```

Introducing Setter Methods

- In other cases, it's desirable for one class to modify another class's field
- However, this must be done safely
- For example:
  - A guard should be able to open a door, but a prisoner should not
  - A bank account balance should not drop below zero
- Setter methods provide a solution

Setter Methods

- Setters are also called mutators
- Setters are usually public
- Setters usually accept arguments
- Setters are void type methods

```
public class Cell {
   …
   public void setName(String name){
      this.name = name;
   }//end method setName
   public void setIsOpen(boolean isOpen){
      this.isOpen = isOpen;
   }//end method setIsOpen
}//end class Cell
```

Designing Setters

- Be careful when you write setters like those shown on the previous slide
  - Prisoners would again have access to their doors
- Sometimes a little thought needs to go into designing a setter method
  - A security door may ask for a security code
  - Banking software may check whether a withdrawal amount would result in a balance less than zero or if the withdrawal amount is negative

Exercise 3, Part 1

- Continue editing the `PrisonTest` project
- Modify the Cell class so that …
  - Getters exist for the name and isOpen fields
  - There's a private 4-digit security code field, it's initialized from the constructor and has no getter method
  - There's a setter for opening/closing the door, and it does the following:
    - Accepts a security code as an argument
    - Prints if the code is incorrect
    - If the code is correct and the door is closed, opens it
    - If the code is correct and the door is open, closes it
    - Prints if the door is opened or closed

Exercise 3, Part 2

- Modify the `Prisoner` class so that …
  - The display() method prints the cell name
  - The openDoor() method is removed
- Modify the main method so that …
  - The Cell is instantiated properly
  - The prisoner no longer tries to open the cell door
  - It tests a cell class's ability to open and close its door
    - Try supplying both correct and incorrect security codes

Continuing to Develop This Software

- Currently, the main method tests a Cell door's ability to open and close based on a security code
- Testing allows us to confirm that this feature is implemented properly
  - If the feature doesn't work, it should be fixed
  - If the feature does work, it's safe to include this feature as part of another feature
- A possible next step would be to develop a Guard class with a method for inputting a security code
  - Ultimately a guard, not the main method, would be responsible for inputting a security code

The Role of the Main Method

- Some programs are driven by physical objects
- Some programs are driven by buttons
- In this exercise, the main method models actions that would drive the program
  - Calling `bubba.openDoor()` models a prisoner trying to open their cell door
  - Calling `cellA1.setIsOpen(1234)` models a person who entered a security code

Exercise 4

- Continue editing the `PrisonTest` project
- Encapsulate the `Prisoner` class
  - Make its fields private
  - Provide getters and setters for every field

That Exercise Wasn't Fun!

- Was Exercise 4 tedious and did it make you groan?
- Some programmers prefer the control of encapsulating fields themselves
- Other programmers would rather have NetBeans do the work for them
  - There's a shortcut
  - NetBeans can encapsulate fields for you

NetBeans Encapsulation Trick

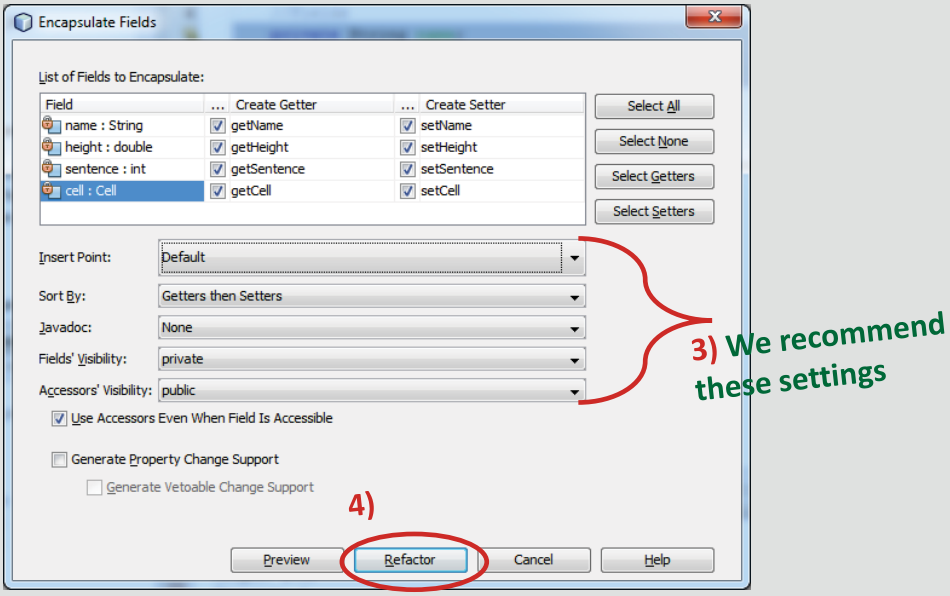
1. **Highlight** the fields that you want to encapsulate

```
3   public class Prisoner {
4       //Fields
5       public String name;
6       public double height;
7       public int sentence;
8       public Cell cell;
9
```

2. Right-click and select **Refactor** >> **Encapsulate Fields**

NetBeans Encapsulation Trick

3. Adjust the settings as you like
4. Click Refactor



Summary of Encapsulation

- Encapsulation offers techniques for limiting the visibility of a class
- Access and visibility should be limited as much as possible
- Most fields should be private
- Provide getter methods to return the value of fields
- Provide setter methods to safely modify fields

Summary

- In this lesson, you should have learned how to:
  - Understand object interaction in greater detail
  - Use the private modifier to define class variables
  - Understand the purpose of getter methods
  - Understand the purpose of setter methods