Structural Programming and Data Structures

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CMPUT 102: Methods

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Course Content

• Introduction	• Vectors
• Objects	• Testing/Debugging
• **Methods**	• Arrays
• Tracing Programs	• Searching
• Object State	• Files I/O
• Sharing resources	• Sorting
• Selection	• Inheritance
• Repetition	• Recursion

Lecture 9 – Lecture 10

Objectives of Lecture 9

The structure of a Java Program

- Understand the structure of a Java program and the different classes that form a program.
- Get an introduction to methods and invocation of methods by sending message expressions.
- Comprehend the relationship between program, classes and methods.
- Find out how applications and applets are launched.

Outline of Lecture 9

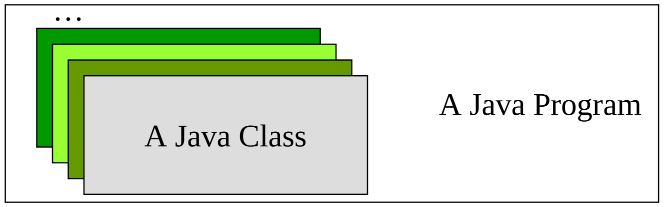
- Program
- Classes
- Methods
- Method dispatch
- Launching an application
- Launching an applet

The Structure of a Java Program

- There are four major structural components of Java programs
  - the program itself
  - classes
  - methods
  - statements

A Java Program - a Set of Classes

- A Java program consists of one or more **classes**.



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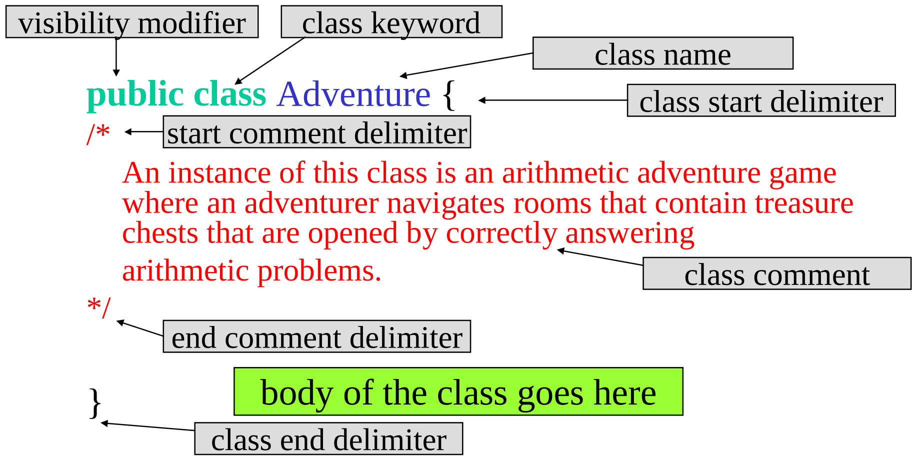
Syntax for a Java Class



```
public class Adventure {
/*
  An instance of this class is an arithmetic adventure game
  where an adventurer navigates rooms that contain treasure
  chests that are opened by correctly answering
  arithmetic problems.
*/

}
```

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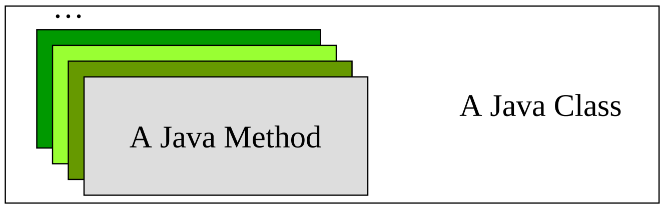
A Java Class - a Set of Methods

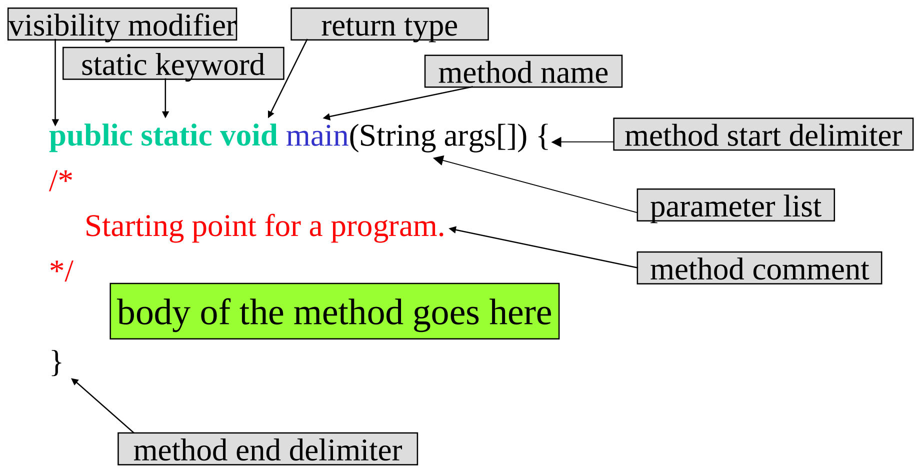
- The body of each Java class includes a set of **methods**.
- A method is some code that performs a single task.



Two Kinds of Methods

- There are two kinds of methods in Java.
- An **instance method** implements a message that is sent to an instance of the class.
- A **static method** implements a task that is independent of any particular object.
- In either case, some code is run and (optionally) a result is returned.

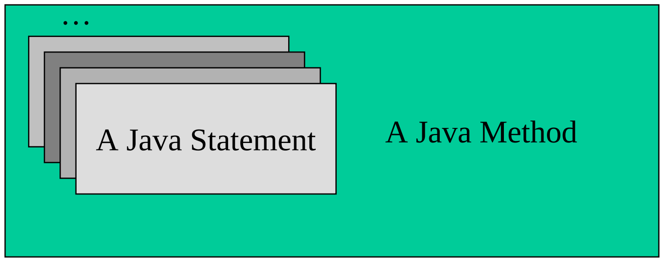
Syntax for a Java Method



```
public static void main(String args[]) {
/*
    Starting point for a program.
*/
    body of the method goes here
}
```

A Java Method - Statements

- The body of a method includes a sequence of **statements**.



Java Statements

- There are many kinds of Java statements.
- Each statement ends with a semi-colon.
- We have already seen four kinds of statements:
  - – variable declaration
  - – import
  - – message expression
  - – assignment statement

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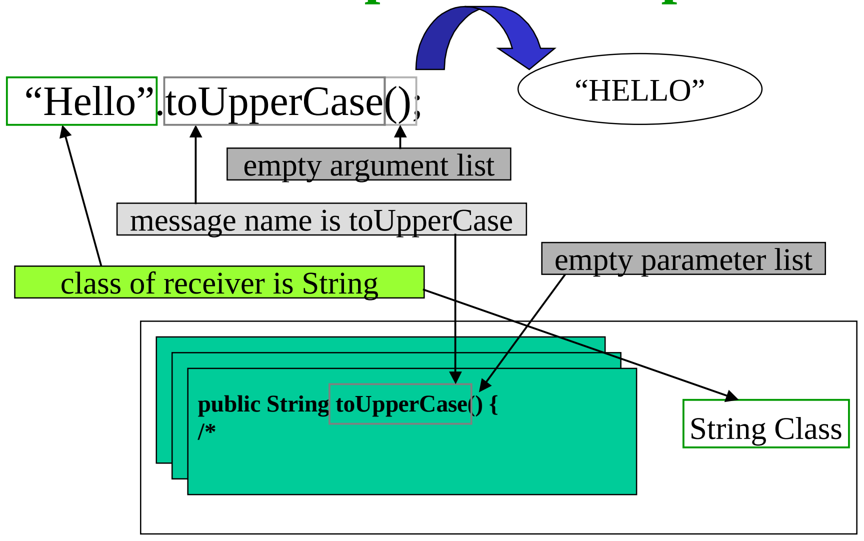
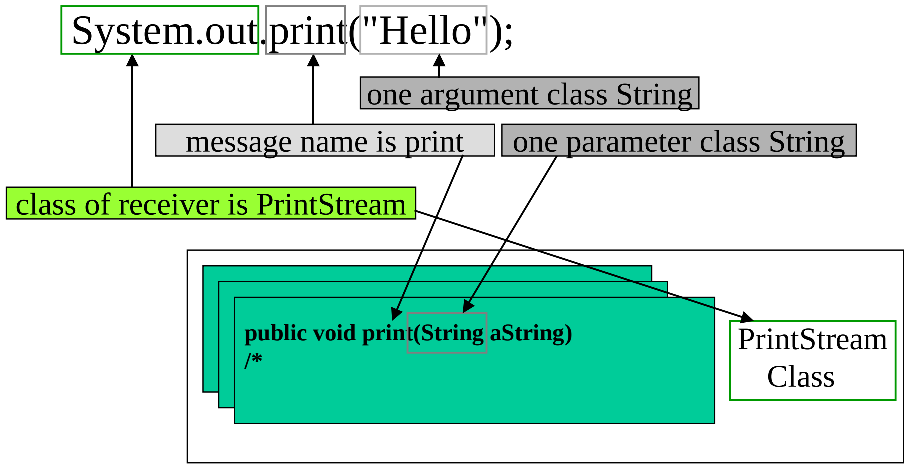
Method Dispatch

- The association of messages to instance methods is called **method dispatch**.
- The class of the receiver object must contain an instance method with the same name as the message name.
- The class of each parameter in the parameter list of the method must match the class of each corresponding argument in the argument list of the message.

Method Dispatch Example 1


"Hello".toUpperCase();
"HELLO"
empty argument list
message name is toUpperCase
empty parameter list
class of receiver is String
public String toUpperCase() {
/*
String Class

Method Dispatch Example 2


System.out.print("Hello");
one argument class String
message name is print
one parameter class String
class of receiver is PrintStream
public void print(String aString)
/*
PrintStream Class

Kinds of Java Programs

- Recall there are three kinds of programs:
  - Applications
  - Applets
  - Libraries
- The structure of all three kinds of programs are the same.
- However, each kind of program is launched differently.
- Libraries are never launched, they are just called by other programs.

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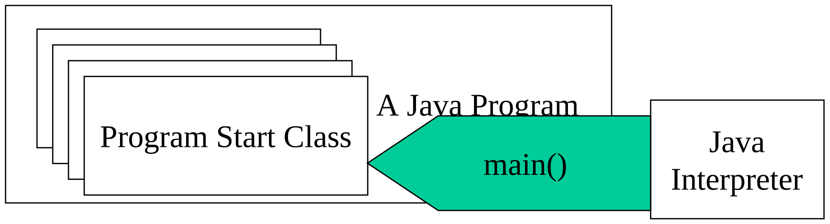
Java Applications - launching

- In a Java application, one class is marked as the special “starting” class.
- When the Java application is launched by the interpreter, it invokes a static method called “main” in the start class.



Java Applications - main Protocol

- The start class must contain a static method for main with protocol:

 public static void main(String args[])

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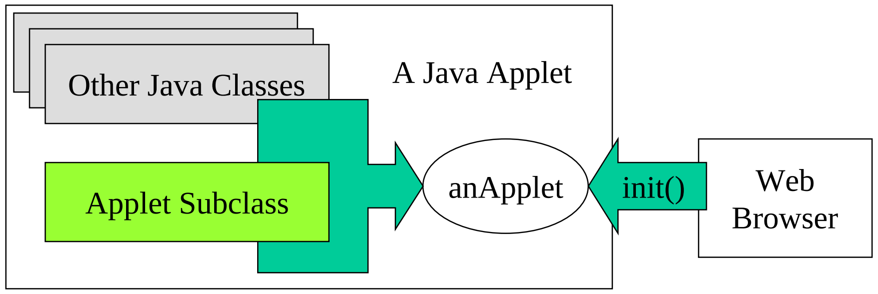
Java Applets - launching

- When the web browser reads a document that tells it to load an applet, it creates an instance of your applet subclass and sends it the instance message ***init().***



Java Applets - init

- The ***init()*** message creates all of the graphical objects in the applet, like buttons and fields and puts them into your applet object.
- If you do not want to put any graphical objects in your applet, you do not need to implement an *init()* method in your applet subclass.

Java Applets - paint

- Whenever your applet must be displayed, the paint message is sent to your applet.
- For example, the paint message is sent after your applet is first initialized and any time the screen must be refreshed.
- The protocol for the paint message is:

```
public void paint(Graphics aGraphics);
```

- The paint method in your applet subclass must display any objects that you did not put in your applet with the init() method.

Objectives of Lecture 10

Implementing Classes - Methods

- Attempt to implement our first class by writing a collection of methods.

Outline of Lecture 10

- Restructuring the start class
- Self reference - this
- The return statement
- Adventure Version 2

The Start Class

- We have already implemented a class in our simple Java programs:

```
public class Adventure {
/* Version 1
    This program is an arithmetic adventure...
*/ .  .  .
```

- However, we have not used this class for anything except to hold the static main() method that starts our program and contains all the code.

The Program Object - Adventure

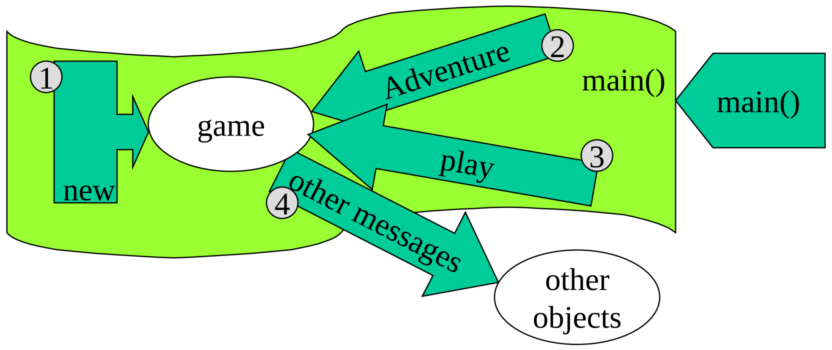
- Instead, we can restructure the code by creating multiple objects and methods.
- In the static main() method, we create an Adventure object and send it the play() message.
- The play() message is implemented by an instance method in the Adventure class.

Multiple Objects and Messages

- The problem is decomposed so that the play() method creates other objects and sends messages to them.
- This is a prototype for all application programs since they can all be structured the same way.

The new main() Method

- Create an instance of the start class, Adventure.
- Send it the play() message to play the game.



Program - Adventure 2.1

```
import java.util.*;

public class Adventure {
/* Version 2
   This program is an arithmetic adventure game ...
*/

/* Constructors */
   public Adventure () {
   /*
        Initialize an Adventure by creating the appropriate
        objects.
   */
   }
```

Program - Adventure 2.2

```
/* Main program */

   public static void main(String args[]) {
        Adventure      game;

        game = new Adventure();
        game.play();
   }
```

Outline of Lecture 10

- Restructuring the start class
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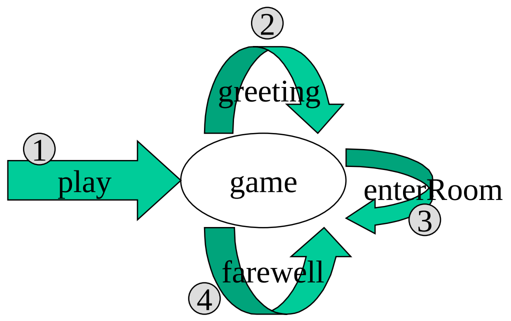
Self- Referencing

- Inside of a method, we often need to send a message to the receiver of the current message.
- That is, we need an object reference to the current object.



The Java Variable called *this*

- In a natural language, self referencing is done using the word me or I.
- In Java, the word **this** is used for self reference.
- If the variable **this** appears in a method, it refers to the the receiver object of that method.

Program - Adventure 2.3

```
/* Private Instance Methods */
   private void play() {
   /*
        Play the Adventure game.
   */

        String  name;
        Integer tokens;

        name = this.greeting();
        tokens = this.enterRoom(name);
        this.farewell(name, tokens);
   }
```

Program - Adventure 2.4

```
private void farewell(String  userName,
                              Integer tokenCount) {
/*
     Say farewell to the user with the given name and
     report the given count of tokens earned.
*/

     System.out.print("Congratulations ");
     System.out.print(userName);
     System.out.print(" you have left the game with ");
     System.out.print(tokenCount);
     System.out.println(" tokens.");
}
```

Outline of Lecture 10

- Restructuring the start class
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The Return Statement

- A **return statement** is used in a method to return the result object or value.
- The syntax of the return statement is:
  <return statement> ::= return <reference>
- The class of the object or value reference that is returned must match the return type specified in the method signature.

Outline of Lecture 10

- Restructuring the start class
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- Adventure Version 2

Program - Adventure 2.5

```
private String greeting() {
/*
     Greet the user and answer a String that represents
     the player’s name.
*/
     String  playerName;

     System.out.println("Welcome to the Arithmetic Adventure game.");
     System.out.print("The date is ");
     System.out.println(new Date());
     System.out.println();
     System.out.print("What is your name?");
     playerName = Keyboard.in.readString();
```

Program - Adventure 2.6

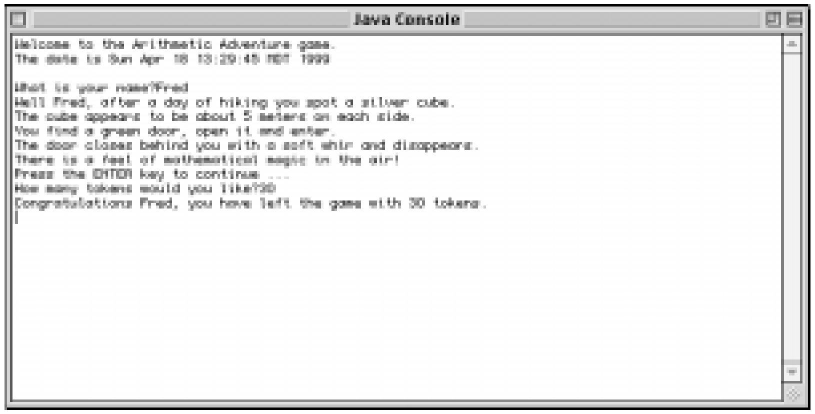
```
     System.out.print("Well ");
     System.out.print(playerName);
     System.out.println(", after a day of hiking you spot a silver cube.");
     System.out.println("The cube appears to be about 5 meters on each side.");
     System.out.println("You find a green door, open it and enter.");
     System.out.println("The door closes behind you with a soft whir and disappears.");
     System.out.println("There is a feel of mathematical magic in the air.");
     Keyboard.in.pause();
     return playerName;
}
```

Program - Adventure 2.7

```
private Integer enterRoom(String theName) {
/*
    The user with the given name has entered the
    first room. After the adventure is done, return the
    number of tokens obtained during the game.
*/
    Integer myTokens;

    System.out.print("How many tokens would you like, ");
    System.out.print(theName);
    System.out.print("?");
    myTokens = Keyboard.in.readInteger();
    return myTokens;
}
```

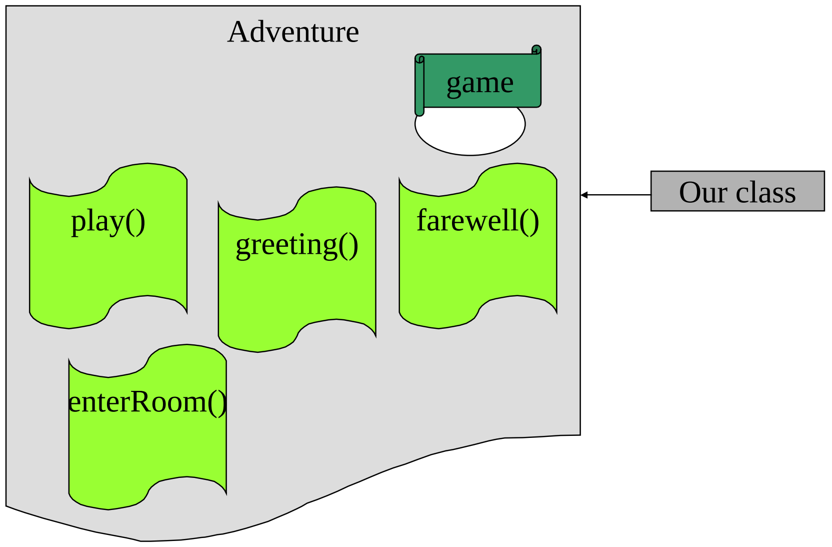
Adventure 2 Output



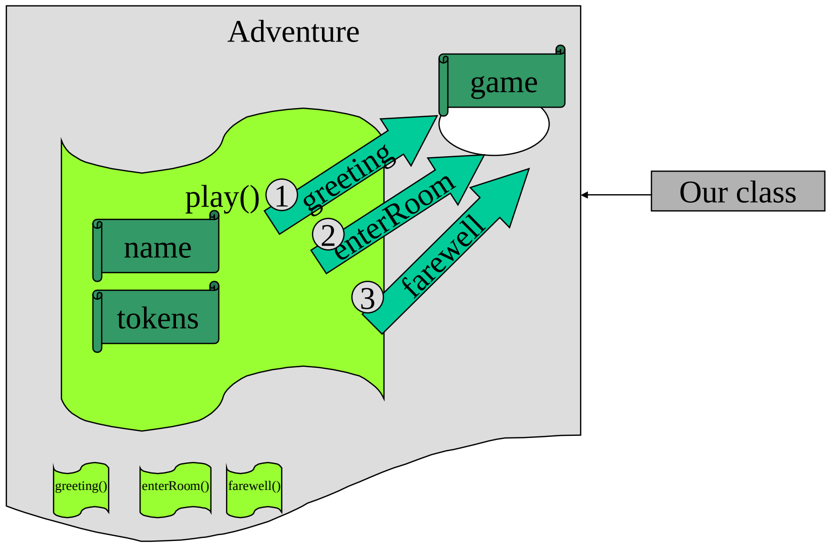
```
Welcome to the Arithmetic Adventure game.
The date is Sun Apr 18 13:29:45 MDT 1999

What is your name?Fred
Well Fred, after a day of hiking you spot a silver cube.
The cube appears to be about 5 meters on each side.
You find a green door, open it and enter.
The door closes behind you with a soft whir and disappears.
There is a feel of mathematical magic in the air!
Press the ENTER key to continue ...
How many tokens would you like?30
Congratulations Fred, you have left the game with 30 tokens.
```

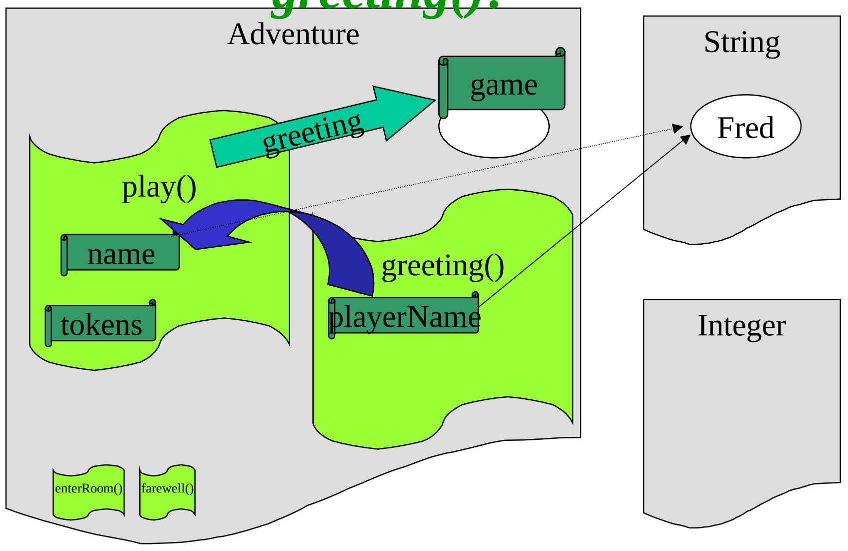
The Big Picture



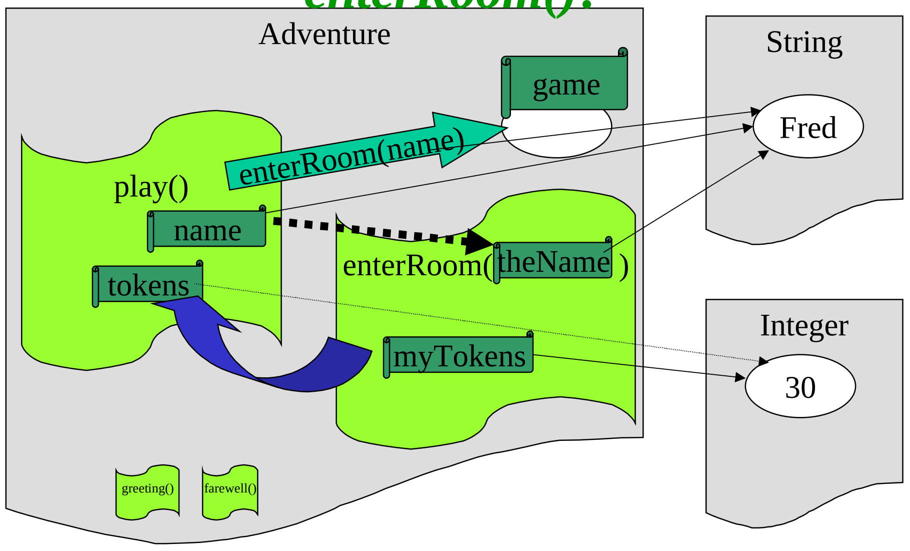
What happens in *play()*?



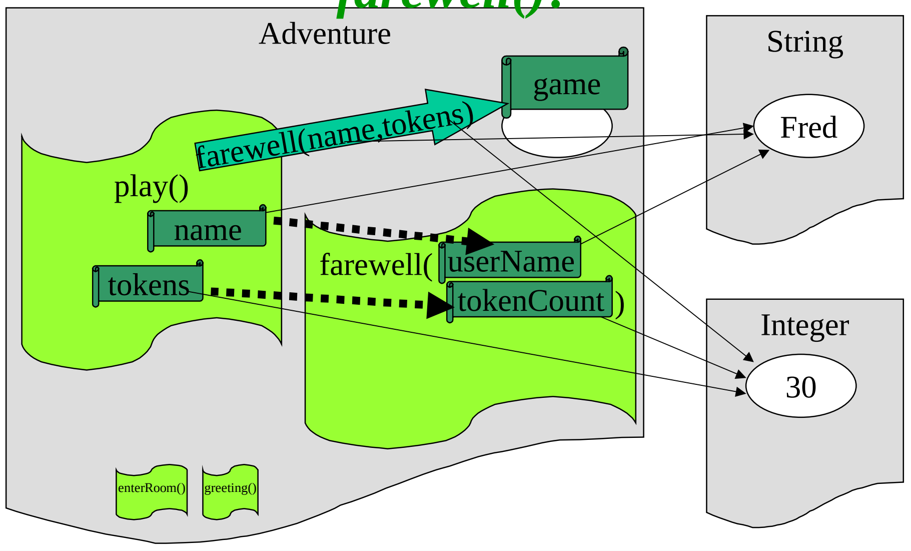
What happens between *play()* and *greeting()*?



What happens between *play()* and *enterRoom()*?



What happens between *play()* and *farewell()*?


Adventure
game
farewell(name,tokens)
play()
name
tokens
farewell(userName
tokenCount)
enterRoom()
greeting()
String
Fred
Integer
30