Objects and Values

Cmput 114 - Lecture 4

Department of Computing Science

University of Alberta

About This Lecture

- **In this lecture, we will learn about values and how they differ from objects.**
- **We also learn how to do simple computations with values.**

Outline

- **Objects versus values**
- **Pure and hybrid languages**
- **Java values and primitive types**
- **Some Java operators**

Objects versus Values

- **Some real world entities are so simple that we represent them by values instead of by objects.**
- **A value has no protocol, so it cannot respond to messages.**
- **However, values can be used as arguments in messages.**
- **Values can also be returned as the results of messages.**

Pure Paradigm Languages

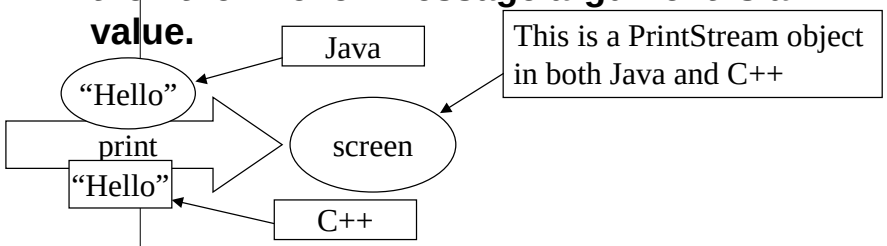
- **How simple is simple enough to represent as a value?**
- **The answer depends on the programming language used.**
- **In “pure” procedural programming languages like C and Pascal, there are no objects, only values.**
- **In “pure” object-oriented languages like Smalltalk, there are no values, just objects.**

Hybrid Programming Languages

- **Languages with both objects and values are object-procedural hybrid languages.**
- **Hybrid languages differ on what is an object and what is a value.**
- **In Java, numbers can be represented by values or objects while in C++ they are values.**
- **In Java, strings are objects while in C++ they are values.**
- **In both languages, Streams are objects.**

Simple Program in Java and C++

- **If our simple program is expressed in Java, then the “Hello” message argument is an object.**
- **If our simple program is expressed in C++, then the “Hello” message argument is a value.**



Java Values - Primitive Types

- **We group similar kinds of Java values together so that every value has a primitive type.**
- **For example, the numbers 3, 4 and 5 have primitive type int.**
- **Since a value is not an object, it does not have a class.**
- **To avoid saying "the class of an object or the primitive type of a value", we use the word type to mean class or primitive type.**

Java Values

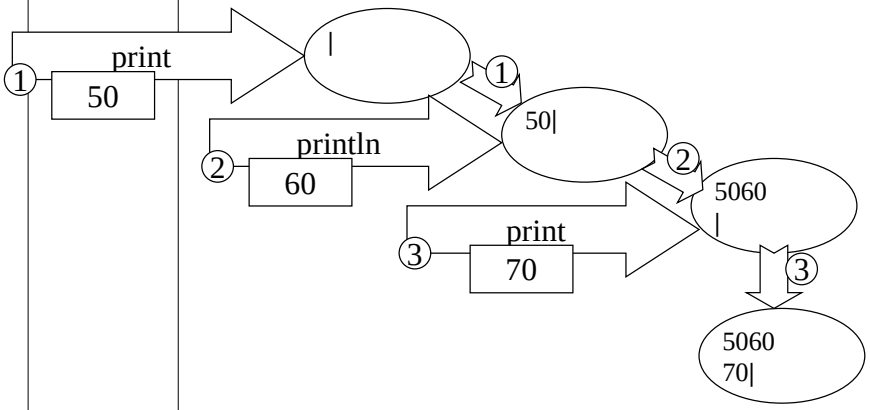
- **Here are some of the primitive types for Java values:**

int	**43 -12 9999999**
char	**‘H’ ‘\’’ ‘\n’ (newline) ‘\t’ (tab)**
float	**43.0f -12.5f 9.5E-5f**
boolean	**true false**

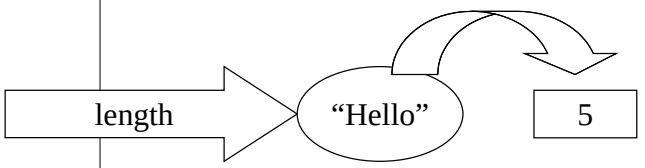
Computing with Values

- **Since we cannot send messages to values, how can we do any computing with values?**
- **There are three ways to use values:**
  - **use them as arguments to messages**
  - **return them as the results of a message**
  - **use operators on them**

Using Values as Arguments

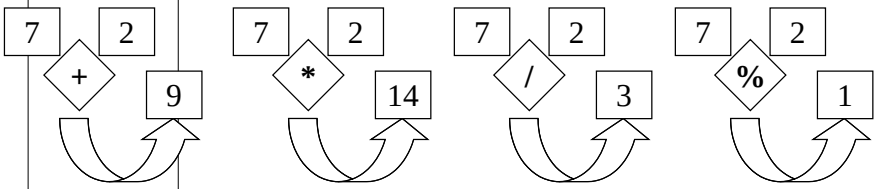


Using Values as Results



Java Operators

- **Values can be manipulated using operators.**
- **Operators are not messages!**
- **For example, there are some arithmetic operators that take numerical operands and compute numerical results.**



Object Creation, Object References and Variables

Cmput 114 - Lecture 5
Department of Computing Science
University of Alberta

About This Lecture

- **In this lecture we will learn how to create objects in our language independent diagram world.**
- **We will learn about various kinds of object references that can be used to identify the objects that we want to use.**
- **We will also study different kinds of variables including static variables and local variables.**

Outline

- **Object creation and Date example**
- **References**
  - **Literals**
  - **Values**
  - **Variables**
  - **Constants**
- **Static variables**
- **Local variables**
- **Message Parameters**

Object Creation is Needed

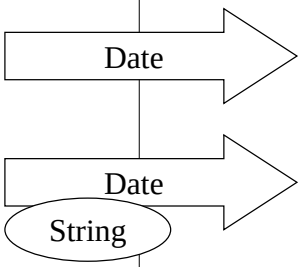
- When we express a computation using a diagram, we never have to create any objects, we just draw them and then send messages to them.
- In a written program, we must provide some instructions to create objects before we can send any messages to them.

Object Creation

- Every object must be created before it can be used.
- An object creation primitive creates a new "empty" object.
- A custom message called a constructor is sent to the object to initialize its state.
- A class may have more than one constructor.
- In many languages, the name of the constructor is the name of the class.

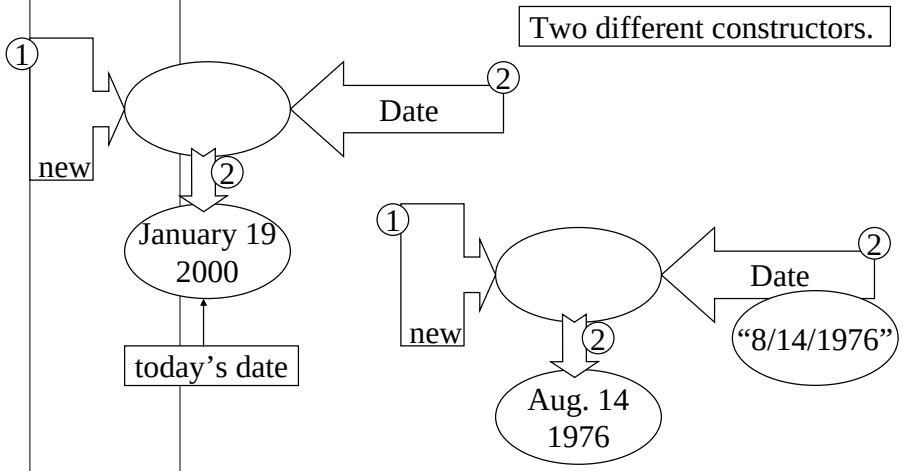
Partial Constructor Protocol - Date

- All constructors have the same name, but differ in the types of the argument objects.



- Set the new Date to today.
- Set the new Date to the Date represented by the argument String.

Object Creation - Date



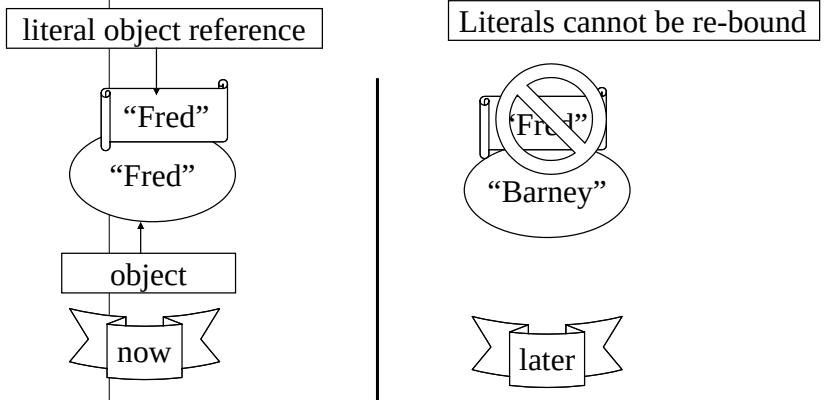
Object References are Needed

- In a diagram, we can send a message to any object that we have drawn simply by pointing a message arrow at it.
- In a written program, we need to have some notation for referring to objects so we can send messages to them.
- If we create an object and don't have a reference to it, we can never use it.

Object References - Literal

- An object reference is a language expression that refers to an object.
- The simplest kind of object reference is a literal object reference.
- A literal object reference refers to the same object at all times.
- You can think of a literal object reference as a nameplate attached to an object.

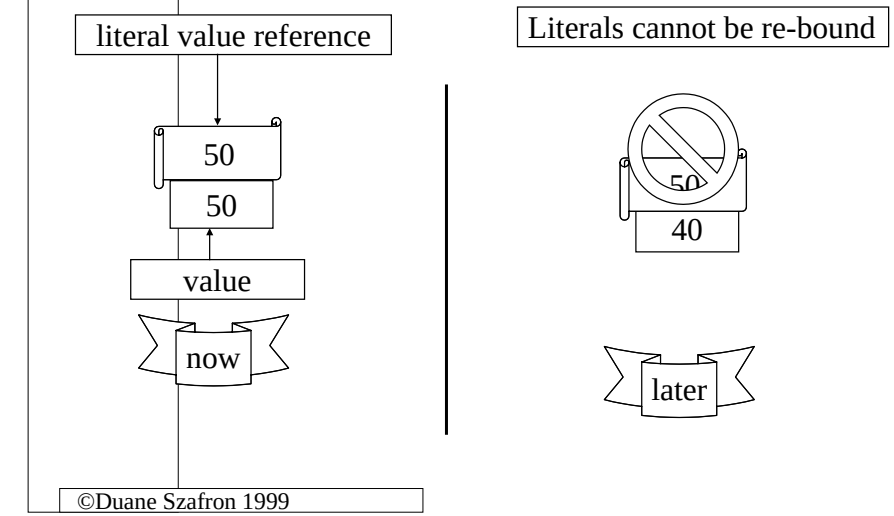
Literal Object References - String



Value References

- In a hybrid language, a value reference is a language expression that refers to a value.
- The simplest kind of value reference is a literal value reference that refers to the same value at all times.
- You can think of a literal value reference as a nameplate attached to a value.
- A literal is either a literal object reference or a literal value reference.

Literal Value References - ints



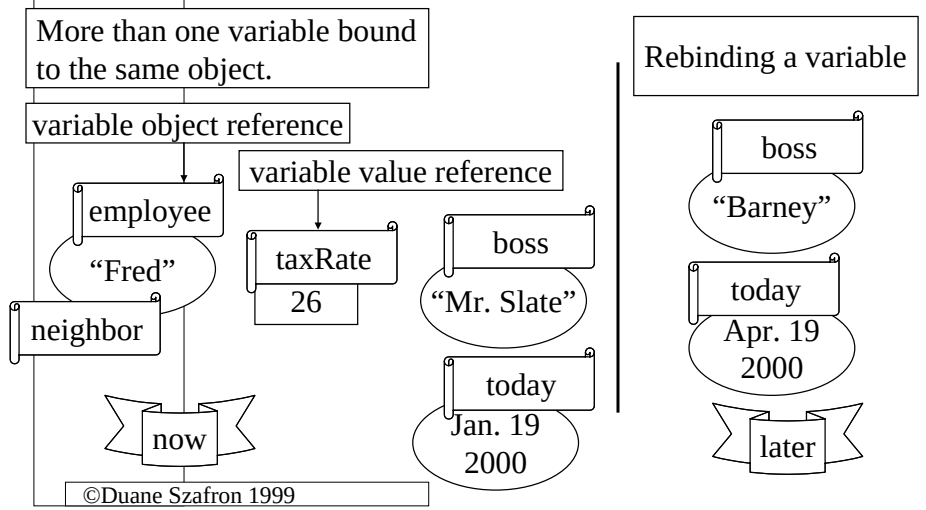
Variables

- **A variable object reference is an object reference that may refer to different objects at different times.**
- **A variable value reference is a value reference that may refer to different values at different times.**
- **A variable is either a variable object reference or a variable value reference.**
- **A variable is said to be bound to its object or value.**

Re-binding Variables

- **A variable can be re-bound to a different object or value.**
- **You can think of a variable as a nameplate that can be moved.**
- **However, in some languages, a variable is restricted to objects or values of a particular type called its declared type.**
- **More than one variable can be bound to the same object or value at the same time.**

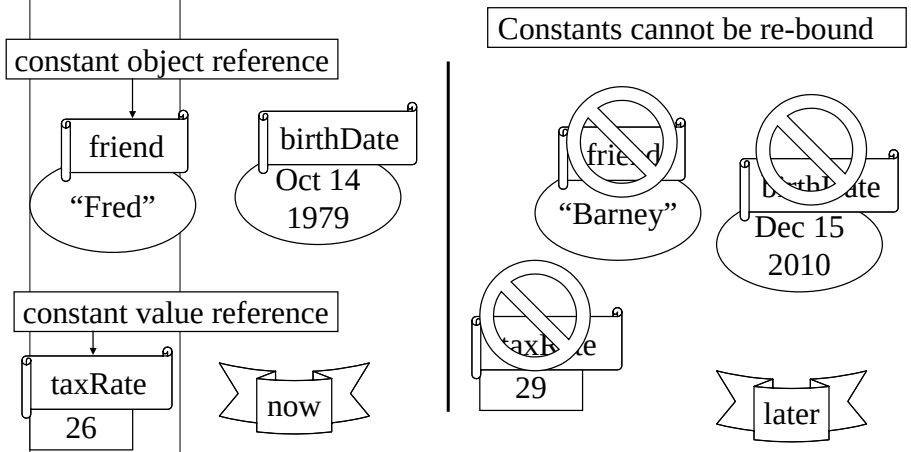
Variables - Example



Constants

- **A constant is like a variable, but once bound to an object or value it cannot be rebound.**
- **It is different than a literal since:**
  - **it is not restricted to those types that have literals**
  - **its language notation is like a variable**

Constants - Example



Kinds of Variables

- **There are four kinds of variables:**
  - **static (class) variables**
  - **local (temporary or method) variables**
  - **message parameters**
  - **instance (object) variables**
- **Every variable has two characteristics.**
- **The scope or visibility is the region of program code that can use the variable.**
- **The lifetime is the time that the variable exists (can be used).**

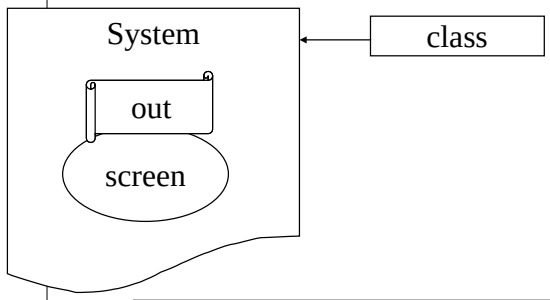
Static Variables

- **A static variable or class variable is declared in a class.**
- **Its lifetime is the entire time that the program is run.**
- **Its scope is either:**
  - **public (the entire program)**
  - **private (the class where it is declared)**
- **Static constants are also allowed.**

Public Static Variables

- **There may be three different types involved with a public static variable.**
- **Recall that the declared type of a variable is the type of object or value to which it can be bound.**
- **The exporting class is the class in which it is declared.**
- **The using class is the class in which it is used to reference an object or value.**

Public Static Variables - out

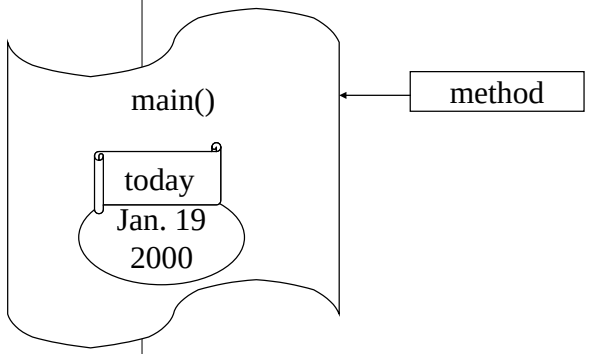


The exporting class of out is System.
The declared type of out is PrintStream.
It is actually a constant.

Local Variables

- **A local variable or temporary variable or method variable is declared in a block of code called a method.**
- **Its lifetime is the time that the method is running.**
- **Its scope is the method it is declared in.**
- **Local constants are also allowed.**

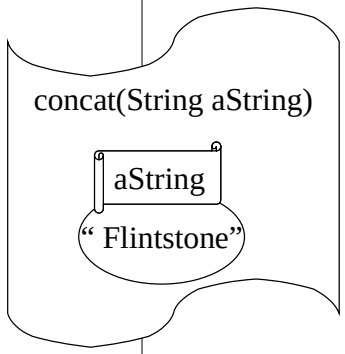
Local Variables - Example



Message Parameters

- **A message parameter is declared at the start of a block of code called a method.**
- **A message parameter is bound to an argument object or value when the method is called and cannot be re-bound.**
- **Its lifetime is the time that the method is running.**
- **Its scope is the method it is declared in.**

Message Parameters - Example



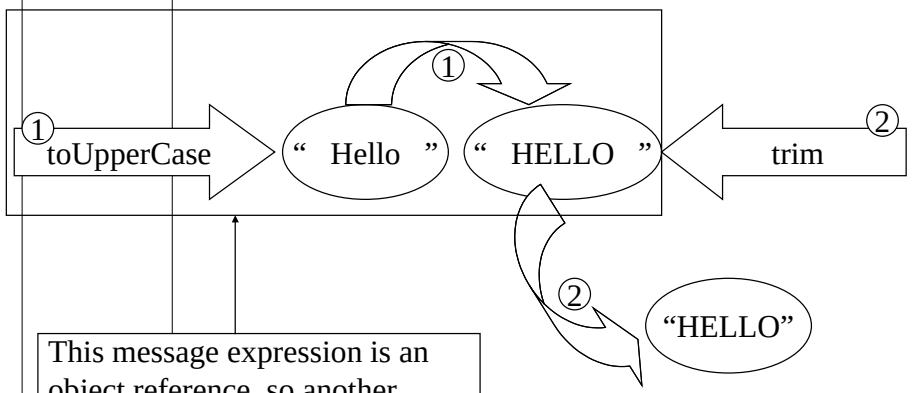
Instance Variables

- **We will discuss instance variables in a future lecture.**

General Object References

- **Recall that an object reference is any language expression that refers to an object and a value reference is any language expression that refers to a value.**
- **There are many other kinds of references in addition to literals, variables and constants.**
- **For example, since a message expression returns an object or value, the message expression itself is also a reference.**

Message Expression Object Reference



This message expression is an object reference, so another message can be sent to the result