University of British Columbia
CPSC 111, Intro to Computation
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Constants, Objects, Strings

Lecture 4, Tue Jan 17 2006

based on slides by Kurt Eiselt

http://www.cs.ubc.ca/~tmm/courses/cpsc111-06-spr

Reading This Week

- Rest of Chap 2
  - 2.3-4, 2.6-2.10
- Rest of Chap 4
  - 4.3-4.7

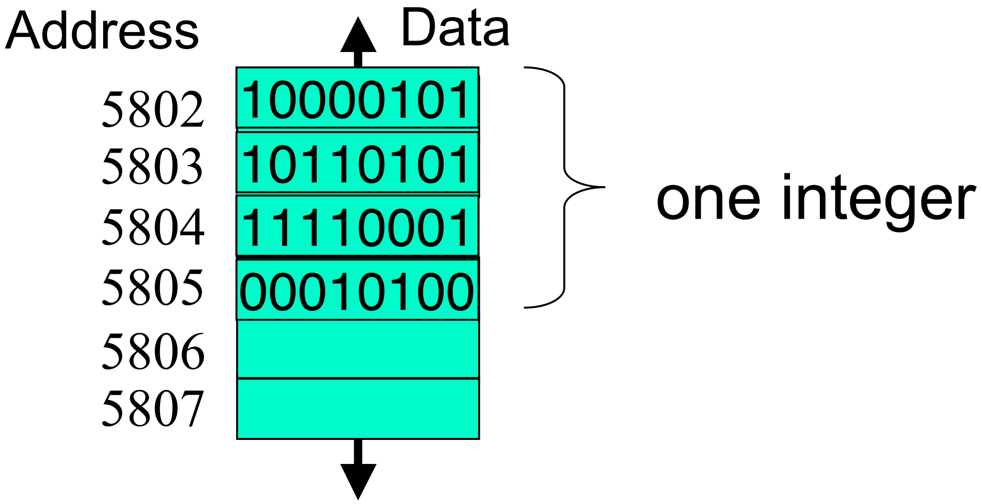
Objectives

- Understand when to use constants
- Understand difference between classes and objects
- Understand difference between objects and primitive data types

Recap: Data Type Sizes

Type	Size	Min	Max
`int`	4 bytes	-2,147,483,648	2,147,483,647
`double`	8 bytes	**approx -1.7E308** **(15 sig. digits)**	**approx 1.7E308** **(15 sig. digits)**

- fixed size, so finite capacity



Address

Data

5802 10000101

5803 10110101

5804 11110001

5805 00010100

5806

5807

one integer

Recap: Declaration and Assignment

- Variable declaration is instruction to compiler
  - reserve block of main memory large enough to store data type specified in declaration
- Variable name is specified by identifier
- Syntax:
  - *typeName variableName;*
  - *typeName variableName = value;*
    - can declare and assign in one step

- Java first computes value on right side
- Then assigns value to variable given on left side

```
x = 4 + 7;      // what's in x?
```

Recap: Assignment Statements

- Here’s an occasional point of confusion:

```
a = 7;         // what’s in a?
b = a;         // what’s in b?
               // what’s in a now???
System.out.println(“a is “ + a + “b is “ +b);
a = 8;
System.out.println(“a is “ + a + “b is “ +b);
```

- Draw and fill in boxes for your variables at each time step if you’re confused

Recap: Expressions

- expression is combination of
  - one or more operators and operands
  - operator examples: +, *, /, ...
  - operand examples: numbers, variables, ...
- precedence: multiply/divide higher than add/subtract

Recap: Converting Between Types

- Doubles can simply be assigned ints
  - `double socks = 1;`
  - ints are subset of doubles
- Casting: convert from one type to another with information loss
- Converting from real to integer
  - `int shoes = (int) 1.5;`
- Truncation: fractional part thrown away
  - `int shoes = (int) 1.75;`
- Rounding: must be done explicitly
  - `shoes = Math.round(1.99);`

Recap: Primitive Data Types: Numbers

Type	Size	Min	Max
`byte`	1 byte	-128	127
`short`	2 bytes	-32,768	32,767
`int`	4 bytes	-2,147,483,648	2,147,483,647
`long`	8 bytes	-9,223,372,036,854,775,808	9,223,372,036,854,775,807
`float`	4 bytes	approx -3.4E38 (7 sig.digits)	approx 3.4E38 (7 sig.digits)
`double`	8 bytes	approx -1.7E308 (15 sig. digits)	approx 1.7E308 (15 sig. digits)

- Primary primitives are `int` and `double`
  - three other integer types
  - one other real type

Recap: Primitive Data Types: Non-numeric

- Character type
  - named char
  - Java uses the Unicode character set so each char occupies 2 bytes of memory.
- Boolean type
  - named boolean
  - variables of type boolean have only two valid values
    - true and false
  - often represents whether particular condition is true
  - more generally represents any data that has two states
    - yes/no, on/off

What Changes, What Doesn’t?

```
//*****************************************
// Vroom.java Author: Tamara
// Playing with constants
//*****************************************
public class Vroom
{
 public static void main (String[] args)
 {
   double lightYears, milesAway;
   lightYears = 4.35; // to Alpha Centauri
   milesAway = lightYears * 186000 *60*60*24*365;
   System.out.println("lightYears: " + lightYears + "
milesAway " + milesAway);
   lightYears = 68; // to Aldebaran
   milesAway = lightYears * 186000 *60*60*24*365;
   System.out.println("lightYears: " + lightYears + "
milesAway " + milesAway);
 }
}
```

Constants

- Things that do not vary
  - unlike variables
  - will never change
- Syntax:
  - final *typeName variableName;*
  - final *typeName variableName* = *value;*
- Constant names in all upper case
  - Java convention, not compiler/syntax requirement

Programming With Constants

```
public static void main (String[] args)
 {
   double lightYears, milesAway;

   final int LIGHTSPEED = 186000;
   final int SECONDS_PER_YEAR = 60*60*24*365;

   lightYears = 4.35; // to Alpha Centauri
   milesAway = lightYears * LIGHTSPEED * SECONDS_PER_YEAR;
   System.out.println("lightYears:  " + lightYears + "
miles " + milesAway);

   lightYears = 68; // to Aldebaran
   milesAway = lightYears * LIGHTSPEED * SECONDS_PER_YEAR;
   System.out.println("lightYears:  " + lightYears + "
miles " + milesAway);
 }
```

Avoiding Magic Numbers

- magic numbers: numeric constants directly in code
  - almost always bad idea!
    - hard to understand code
    - hard to make changes
    - typos possible
  - use constants instead

Programming With Constants

```
public static void main (String[] args)
 {
   double lightYears, milesAway;
   final int LIGHTSPEED = 186000;
   final int SECONDS_PER_YEAR = 60*60*24*365;

   final double ALPHACENT_DIST = 4.35; // to AlphaCentauri
   final double ALDEBARAN_DIST = 68; // to Aldebaran

   lightYears = ALPHACENT_DIST;
   milesAway = lightYears * LIGHTSPEED * SECONDS_PER_YEAR;
   System.out.println("lightYears:  " + lightYears + " 
miles " + milesAway);
   lightYears = ALDEBARAN_DIST;

   milesAway = lightYears * LIGHTSPEED * SECONDS_PER_YEAR;
   System.out.println("lightYears:  " + lightYears + " 
miles " + milesAway);
 }
```

Programming

- Programming is all about specifiying
  - data that is to be manipulated or acted upon
  - operations that can act upon data
  - order in which operations are applied to data

- So far: specify data using primitive data types
  - come with pre-defined operations like

    +, -, *, and /

Programming with Classes

- What if data we want to work with is more complex these few primitive data types?

Programming with Classes

- What if data we want to work with is more complex these few primitive data types?

- We can make our own data type: create a class
  - specifies nature of data we want to work with
  - operations that can be performed on that kind of data
- Operations defined within a class called methods

Programming with Classes

- Can have multiple variables of primitive types (int, double)
  - each has different name
  - each can have a different value

```
int x = 5;
int y = 17;
```

- Similar for classes: can have multiple instances of class String
  - each has different name
  - each can have different value

```
String name = “Tamara Munzner”;
String computerName = “pangolin”;
```

Programming with Objects

- Object: specific instance of a class
- Classes are templates for objects
  - programmers define classes
  - objects created from classes

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String (“Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                           + " " + lastname);
    }
}
```

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String ("Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                                   + " " + lastname);
    }
}
```

- Declare two different String objects
  - one called **`firstname`** and one called **`lastname`**

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
```

- Variable declaration does not create objects!

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
```

- Variable declaration does not create objects!
    - just tells compiler to set aside spaces in memory with these names
- Spaces will not actually hold the whole objects
    - will hold references: pointers to or addresses of objects
    - objects themselves will be somewhere else in memory

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String ("Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                                   + " " + lastname);
    }
}
```

- So **`firstname`** and **`lastname`** will not contain String objects
  - contain references to String objects

Constructors

- Constructor: method with same name as class
  - always used with **`new`**
  - actually creates object
  - typically initializes with data

```
firstname = new String (“Kermit");
```

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String (“Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                           + " " + lastname);
    }
}
```

- Now create new instance of the String class
  - String object with data “Kermit”
- Puts object somewhere in memory
  - puts address of the object’s location in **`firstname`**:

    `firstname` holds reference to String object with data “Kermit”

Object Example

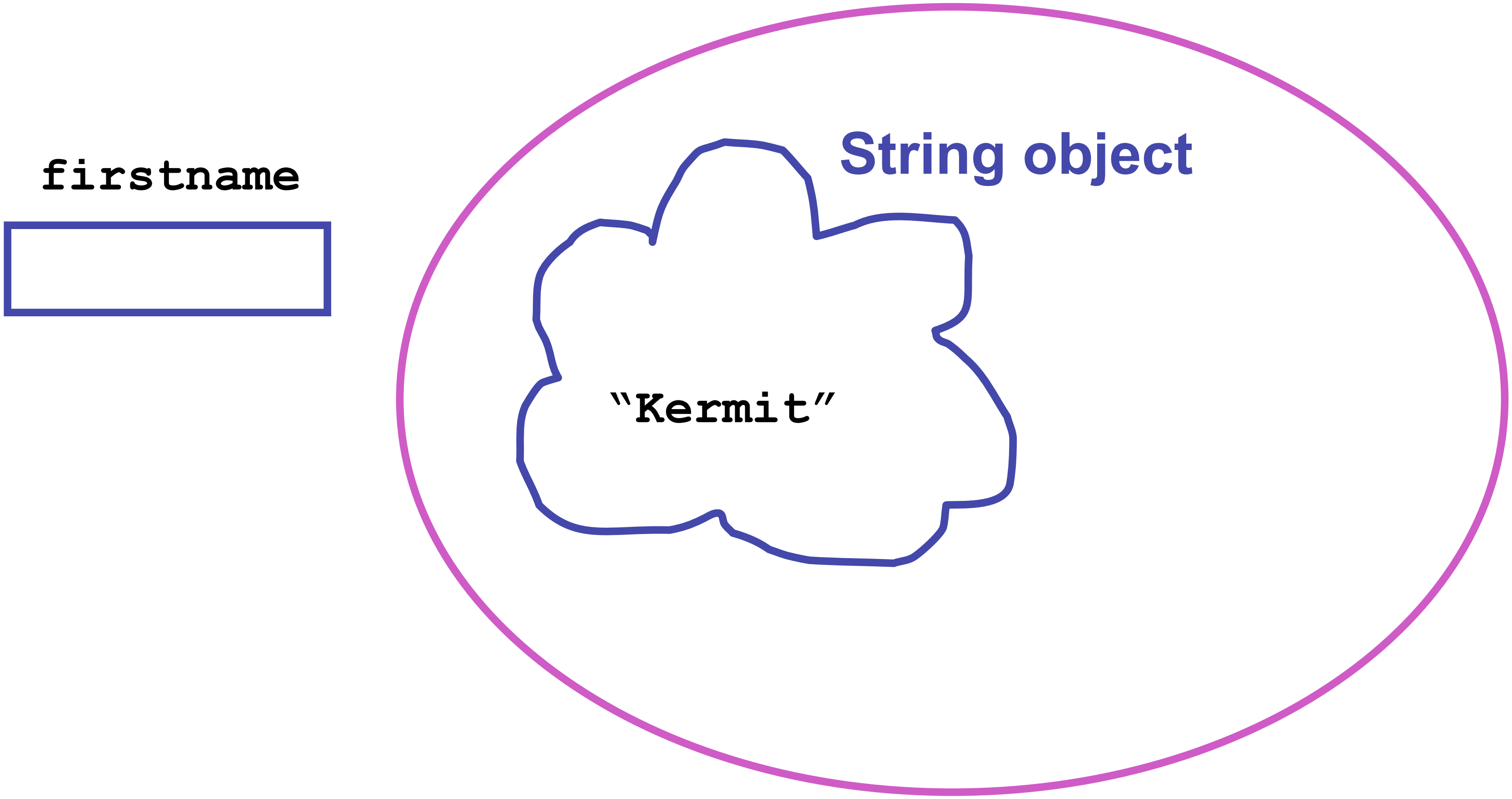
```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String (“Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                                  + " " + lastname);
    }
}
```

- New operator and String constructor method instantiate (create) new instance of String class (a new String object)

Object Example

firstname

Object Example



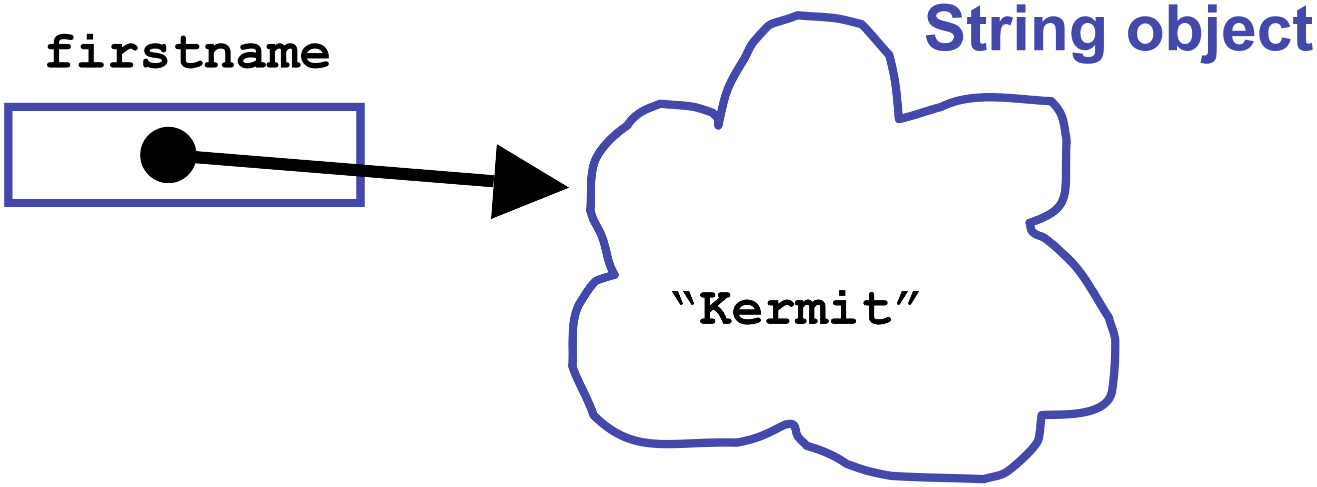
firstname

String object

`"Kermit"`

expression on right side
of assignment operator

Object Example



firstname

String object

“Kermit”

bind variable to
expression on right side
of assignment operator

Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname;
        String lastname;
        firstname = new String (“Kermit");
        lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                                  + " " + lastname);
    }
}
```

- And so on

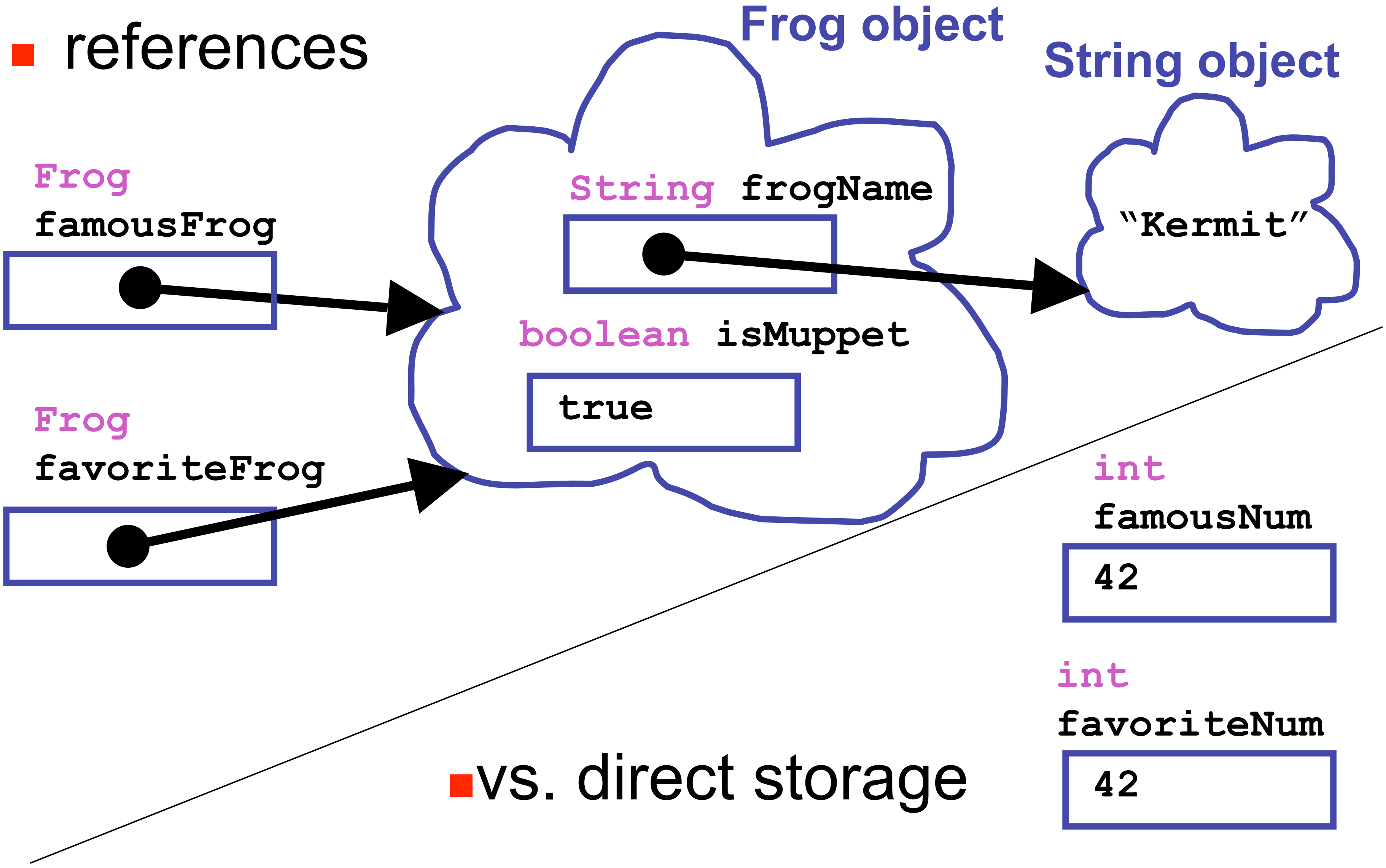
Object Example

```
public class StringTest
{
    public static void main (String[] args)
    {
        String firstname = new String (“Kermit");
        String lastname = new String (“theFrog");
        System.out.println("I am not " + firstname
                           + " " + lastname);
    }
}
```

- Can consolidate declaration, assignment
  - just like with primitive data types

Objects vs. Primitives

- references



Frog object

String object

Frog
famousFrog

Frog
favoriteFrog

String frogName

boolean isMuppet

true

“Kermit”

int
famousNum

42

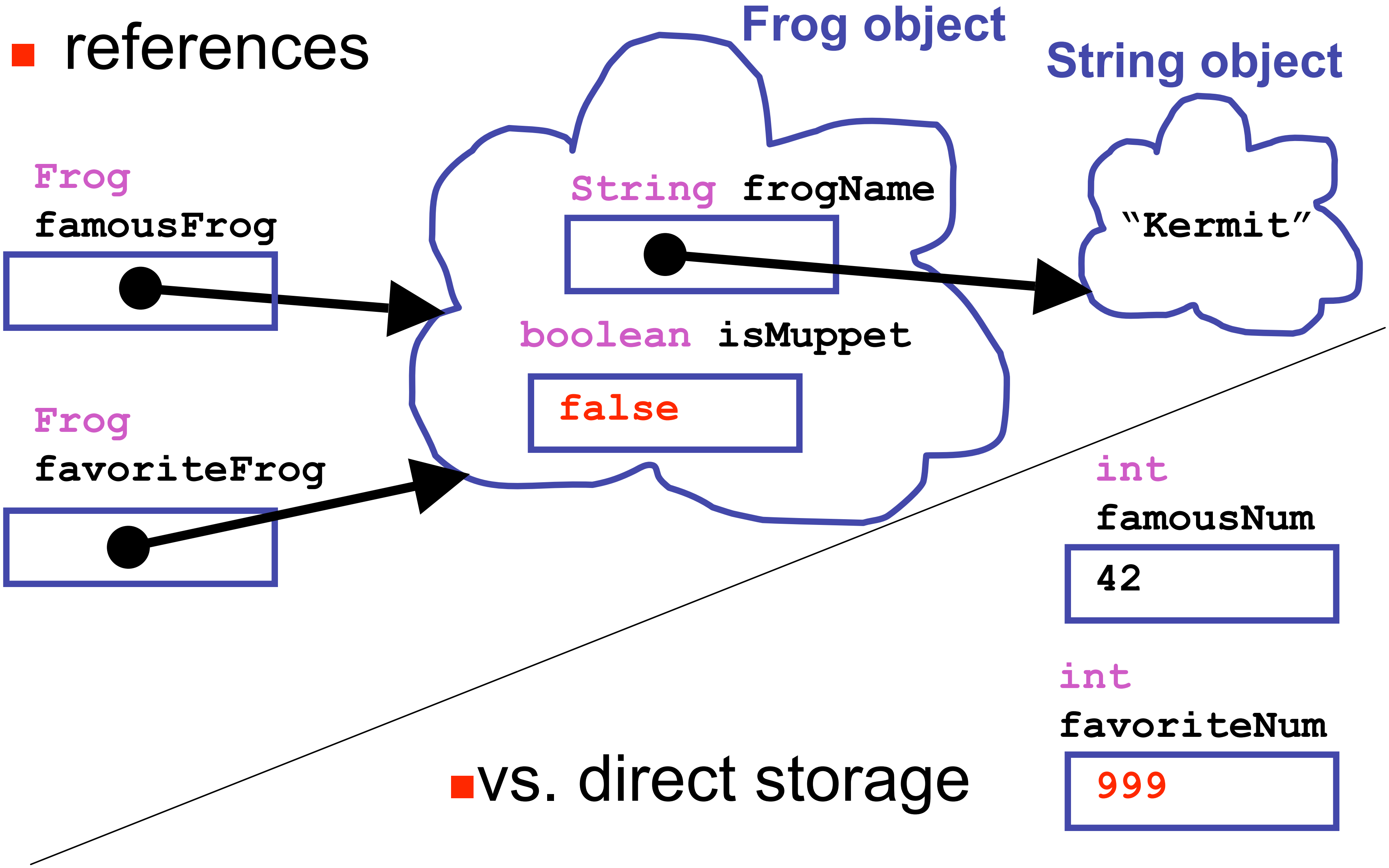
int
favoriteNum

42

- vs. direct storage

Objects vs. Primitives

- references



Frog object

String object

Frog famousFrog

String frogName

"Kermit"

boolean isMuppet

false

Frog favoriteFrog

int famousNum

42

int favoriteNum

999

- vs. direct storage

Class Libraries

- Before making new class yourself, check to see if someone else did it already
  - libraries written by other programmers
  - many built into Java
- Example
  - Java has single-character primitive data type
  - what if want to work with sequence of characters
  - String class already exists

API Documentation

- Online Java library documentation at http://java.sun.com/j2se/1.5.0/docs/api/
  - textbook alone is only part of the story
  - let’s take a look!

- Everything we need to know: critical details
  - and often many things far beyond current need

- Classes in libraries are often referred to as Application Programming Interfaces
  - or just API

Some Available String Methods

```
public String toUpperCase();
```

Returns a new `String` object identical to this object but with all the characters converted to upper case.

```
public int length();
```

Returns the number of characters in this `String` object.

```
public boolean equals( String otherString );
```

Returns true if this `String` object is the same as `otherString` and false otherwise.

```
public char charAt( int index );
```

Returns the character at the given index. Note that the first character in the string is at index 0.

More String Methods

```
public String replace(char oldChar, char newChar);
```

Returns a new `String` object where all instances of `oldChar` have been changed into `newChar`.

```
public String substring(int beginIndex);
```

Returns new `String` object starting from `beginIndex` position

```
public String substring( int beginIndex, int endIndex );
```

Returns new `String` object starting from `beginIndex` position and ending at `endIndex` position

- up to but not including endIndex char:

```
substring(4, 7)    "o K"
```

H	e	l	l	o		K	e	r	m	i	t	F	r	o	g
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Questions?