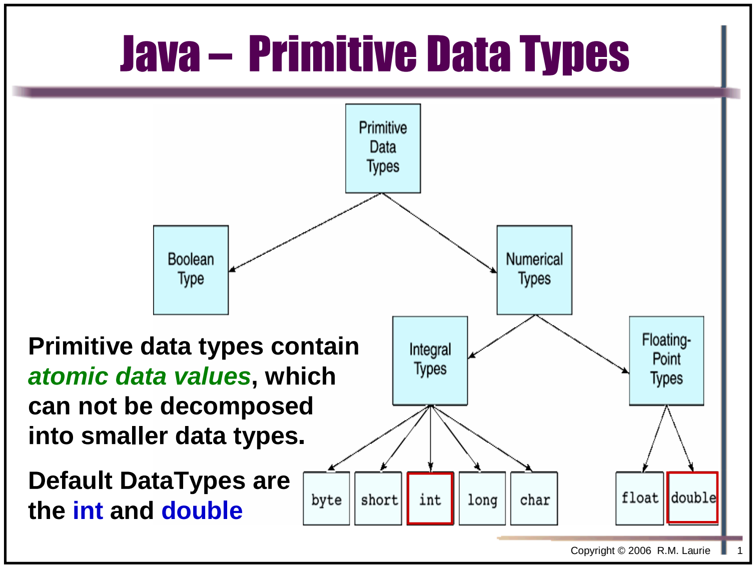
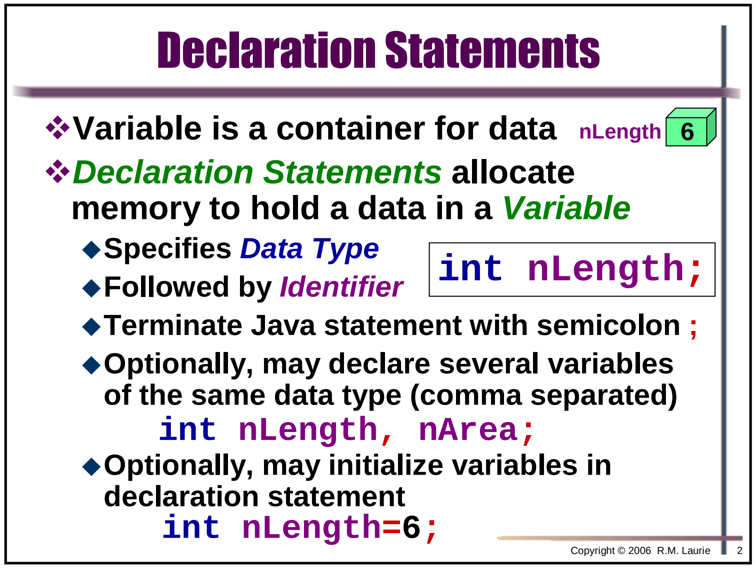


Java – Primitive Data Types

Primitive Data Types
Boolean Type
Numerical Types
Integral Types
Floating-Point Types
byte
short
int
long
char
float
double

Primitive data types contain *atomic data values*, which can not be decomposed into smaller data types.

Default DataTypes are the int and double



Declaration Statements

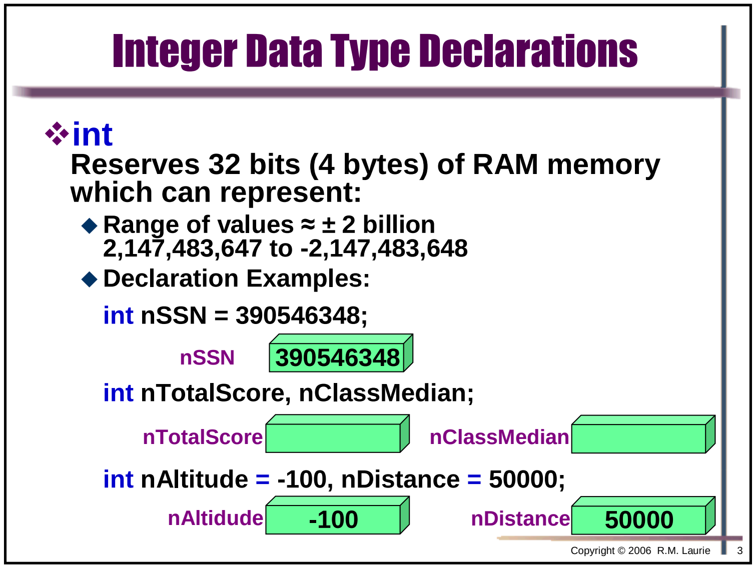
- Variable is a container for data nLength 6
- *Declaration Statements* allocate memory to hold a data in a *Variable*
  - Specifies *Data Type*
  - Followed by *Identifier*
  - Terminate Java statement with semicolon ;
  - Optionally, may declare several variables of the same data type (comma separated)

```
int nLength;
```

```
int nLength, nArea;
```

  - Optionally, may initialize variables in declaration statement

```
int nLength=6;
```



Integer Data Type Declarations

- int
  Reserves 32 bits (4 bytes) of RAM memory which can represent:
  - Range of values ≈ ± 2 billion
    2,147,483,647 to -2,147,483,648
  - Declaration Examples:

int nSSN = 390546348;

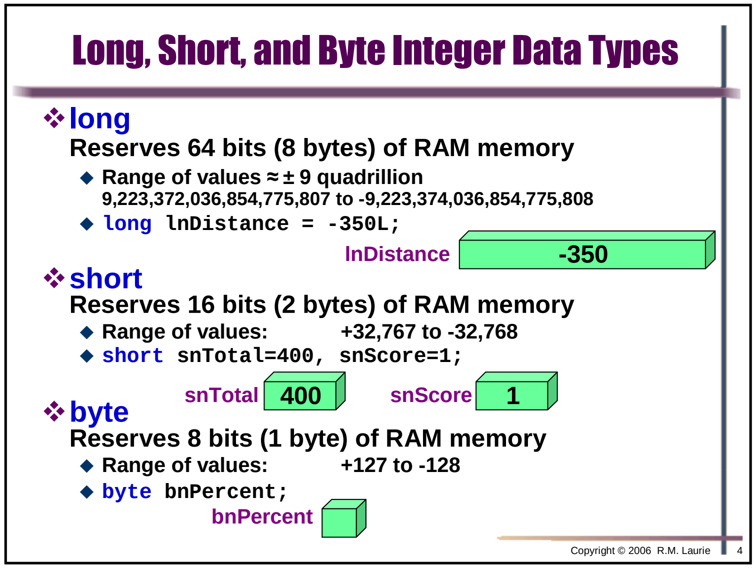
nSSN 390546348

int nTotalScore, nClassMedian;

nTotalScore nClassMedian

int nAltitude = -100, nDistance = 50000;

nAltidude -100 nDistance 50000



Long, Short, and Byte Integer Data Types

- long
  Reserves 64 bits (8 bytes) of RAM memory
  - Range of values ≈ ± 9 quadrillion
    9,223,372,036,854,775,807 to -9,223,374,036,854,775,808
  - `long lnDistance = -350L;`

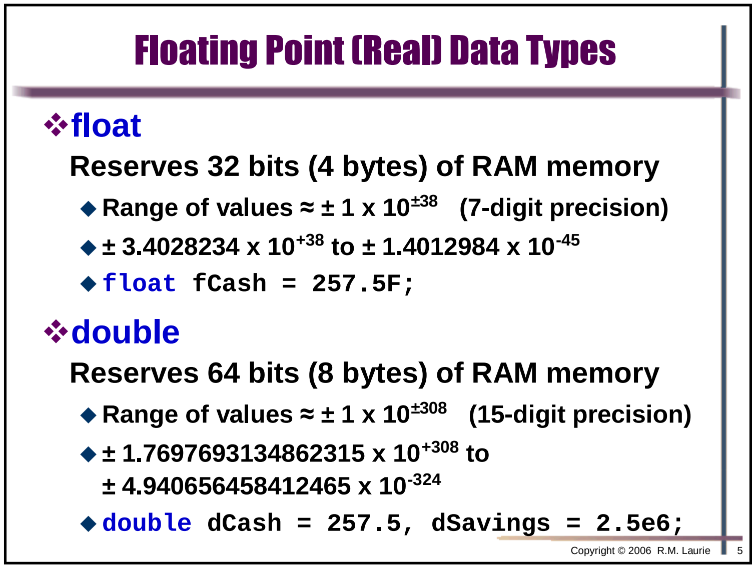
lnDistance -350

- short
  Reserves 16 bits (2 bytes) of RAM memory
  - Range of values: +32,767 to -32,768
  - `short snTotal=400, snScore=1;`

snTotal 400 snScore 1

- byte
  Reserves 8 bits (1 byte) of RAM memory
  - Range of values: +127 to -128
  - `byte bnPercent;`

bnPercent

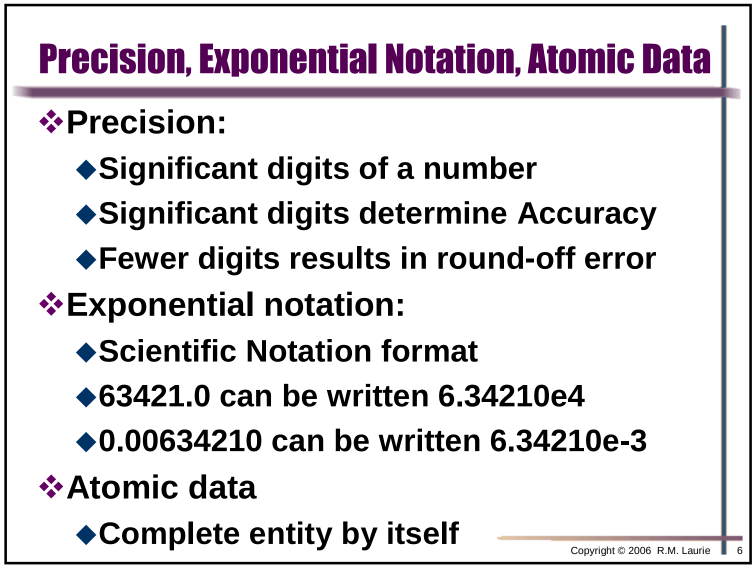


Floating Point (Real) Data Types

- **float**

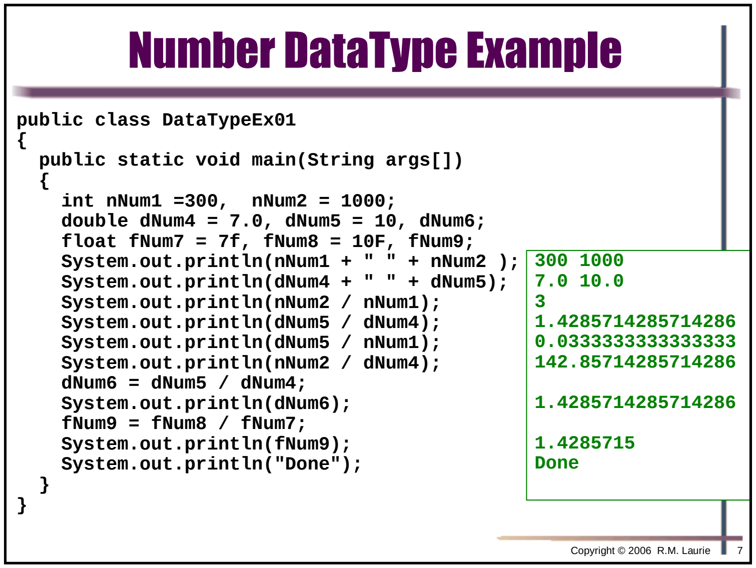
  Reserves 32 bits (4 bytes) of RAM memory
  - Range of values ≈ $\pm 1 \times 10^{\pm 38}$ (7-digit precision)
  - $\pm 3.4028234 \times 10^{+38}$ to $\pm 1.4012984 \times 10^{-45}$
  - `float fCash = 257.5F;`
- **double**

  Reserves 64 bits (8 bytes) of RAM memory
  - Range of values ≈ $\pm 1 \times 10^{\pm 308}$ (15-digit precision)
  - $\pm 1.7697693134862315 \times 10^{+308}$ to $\pm 4.940656458412465 \times 10^{-324}$
  - `double dCash = 257.5, dSavings = 2.5e6;`



Precision, Exponential Notation, Atomic Data

- Precision:
  - Significant digits of a number
  - Significant digits determine Accuracy
  - Fewer digits results in round-off error
- Exponential notation:
  - Scientific Notation format
  - 63421.0 can be written 6.34210e4
  - 0.00634210 can be written 6.34210e-3
- Atomic data
  - Complete entity by itself



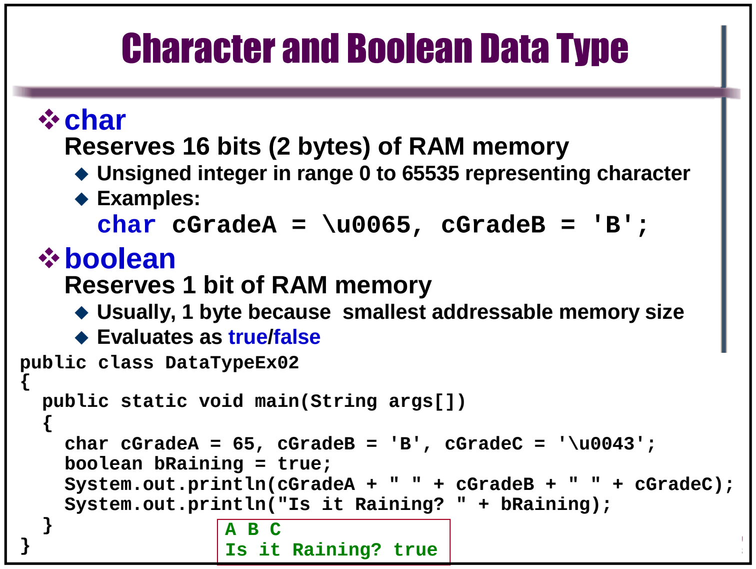
Number DataType Example

```
public class DataTypeEx01
{
  public static void main(String args[])
  {
    int nNum1 =300,  nNum2 = 1000;
    double dNum4 = 7.0, dNum5 = 10, dNum6;
    float fNum7 = 7f, fNum8 = 10F, fNum9;
    System.out.println(nNum1 + " " + nNum2 );
    System.out.println(dNum4 + " " + dNum5);
    System.out.println(nNum2 / nNum1);
    System.out.println(dNum5 / dNum4);
    System.out.println(dNum5 / nNum1);
    System.out.println(nNum2 / dNum4);
    dNum6 = dNum5 / dNum4;
    System.out.println(dNum6);
    fNum9 = fNum8 / fNum7;
    System.out.println(fNum9);
    System.out.println("Done");
  }
}
```

```
300 1000
7.0 10.0
3
1.4285714285714286
0.0333333333333333
142.85714285714286

1.4285714285714286

1.4285715
Done
```



Character and Boolean Data Type

- **char**

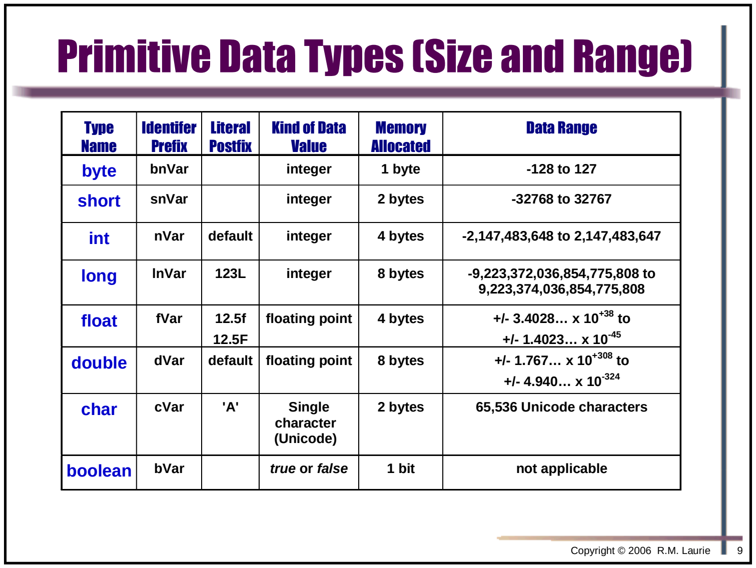
  Reserves 16 bits (2 bytes) of RAM memory
  - Unsigned integer in range 0 to 65535 representing character
  - Examples:

    `char cGradeA = \u0065, cGradeB = 'B';`
- **boolean**

  Reserves 1 bit of RAM memory
  - Usually, 1 byte because smallest addressable memory size
  - Evaluates as true/false

```
public class DataTypeEx02
{
  public static void main(String args[])
  {
    char cGradeA = 65, cGradeB = 'B', cGradeC = '\u0043';
    boolean bRaining = true;
    System.out.println(cGradeA + " " + cGradeB + " " + cGradeC);
    System.out.println("Is it Raining? " + bRaining);
  }
}
```

```
A B C
Is it Raining? true
```



Primitive Data Types (Size and Range)

Type Name	Identifer Prefix	Literal Postfix	Kind of Data Value	Memory Allocated	Data Range
byte	bnVar		integer	1 byte	-128 to 127
short	snVar		integer	2 bytes	-32768 to 32767
int	nVar	default	integer	4 bytes	-2,147,483,648 to 2,147,483,647
long	lnVar	123L	integer	8 bytes	-9,223,372,036,854,775,808 to 9,223,374,036,854,775,808
float	fVar	12.5f 12.5F	floating point	4 bytes	+/- 3.4028… x 10^{+38} to +/- 1.4023… x 10^{-45}
double	dVar	default	floating point	8 bytes	+/- 1.767… x 10^{+308} to +/- 4.940… x 10^{-324}
char	cVar	'A'	Single character (Unicode)	2 bytes	65,536 Unicode characters
boolean	bVar		*true* or *false*	1 bit	not applicable

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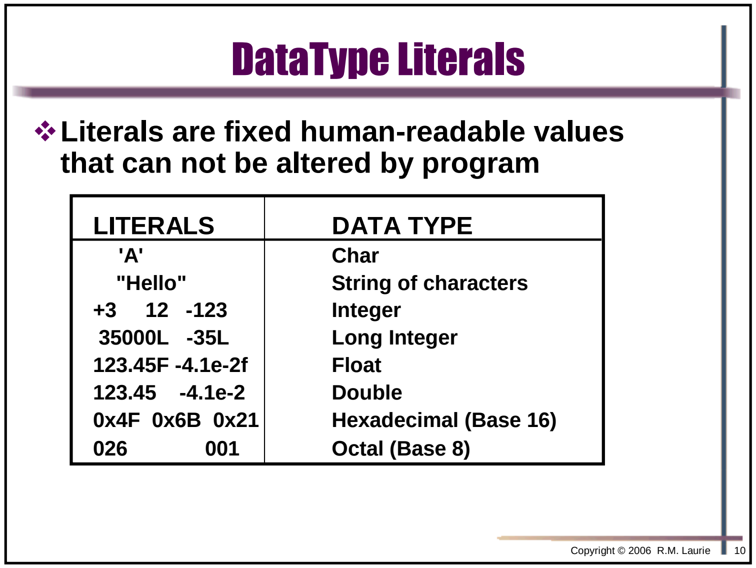

DataType Literals

- ❖ Literals are fixed human-readable values that can not be altered by program

LITERALS	DATA TYPE
'A'	Char
"Hello"	String of characters
+3 12 -123	Integer
35000L -35L	Long Integer
123.45F -4.1e-2f	Float
123.45 -4.1e-2	Double
0x4F 0x6B 0x21	Hexadecimal (Base 16)
026 001	Octal (Base 8)

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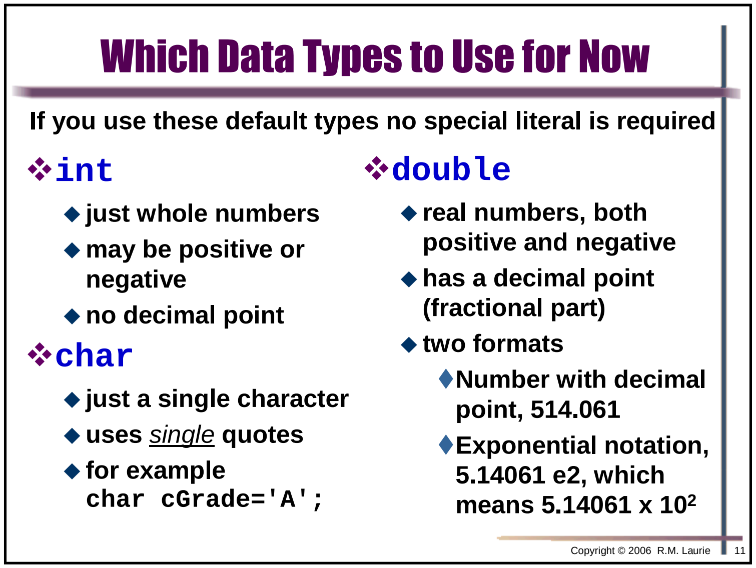

Which Data Types to Use for Now

If you use these default types no special literal is required

- ❖ `int`
  - ◆ just whole numbers
  - ◆ may be positive or negative
  - ◆ no decimal point
- ❖ `char`
  - ◆ just a single character
  - ◆ uses <u>single</u> quotes
  - ◆ for example `char cGrade='A';`
- ❖ `double`
  - ◆ real numbers, both positive and negative
  - ◆ has a decimal point (fractional part)
  - ◆ two formats
    - ♦ Number with decimal point, 514.061
    - ♦ Exponential notation, 5.14061 e2, which means 5.14061 x 10^2

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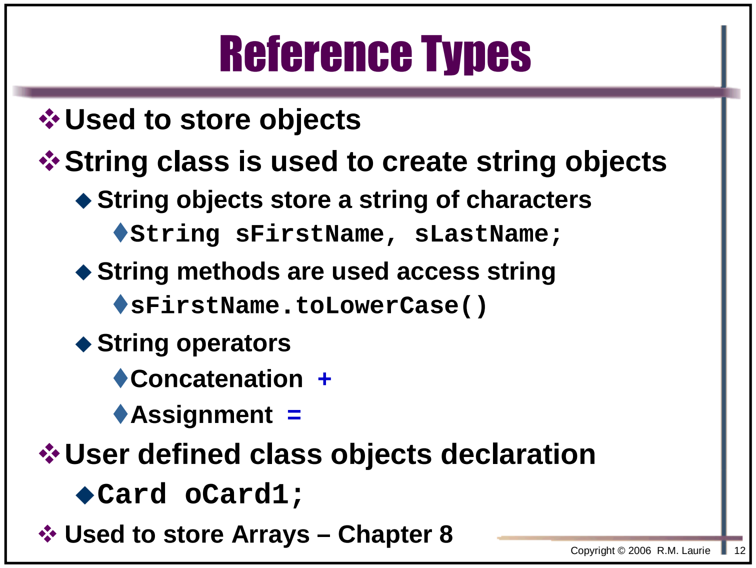

Reference Types

- ❖ Used to store objects
- ❖ String class is used to create string objects
  - ◆ String objects store a string of characters
    - ♦ `String sFirstName, sLastName;`
  - ◆ String methods are used access string
    - ♦ `sFirstName.toLowerCase()`
  - ◆ String operators
    - ♦ Concatenation `+`
    - ♦ Assignment `=`
- ❖ User defined class objects declaration
  - ◆ `Card oCard1;`
- ❖ Used to store Arrays – Chapter 8

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Construct a Data Declaration Section

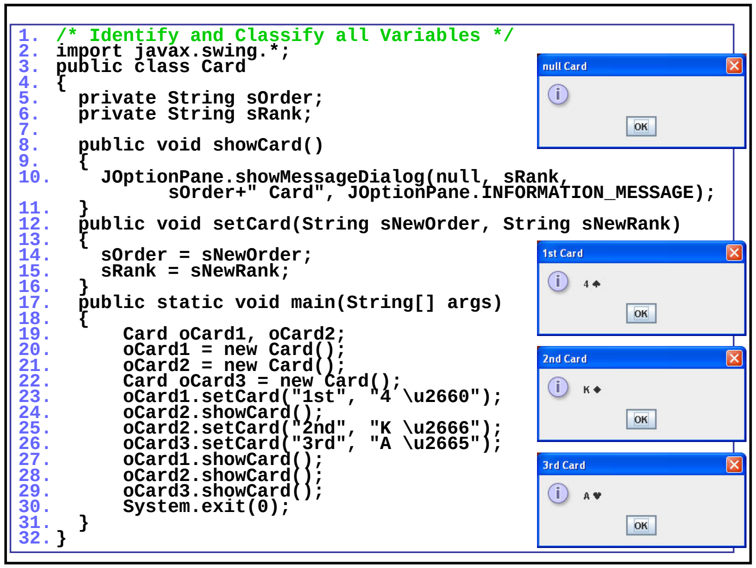
- Dependent on:
  - Variable placement within class
  - Presence or absence of reserved word `static`
- Classifications of variables:
  - *Local* – Within methods and used to create objects
    - Neither an access modifier or static are permitted
  - *Instance* – Within class's body but outside method
    - Every object gets variable of this type, static not permitted
  - *Class* – Within class's body but outside method
    - Part of class but not object, must use static keyword
  - *Parameter* – Within parenthesis of method header
    - Neither an access modifier or static are permitted
    - Used to pass data values to a method

Declaration Statements Syntax

- `optAccessSpecifier dataType varName;`
  - private – Access variables only within class methods
  - public – Access variables from anywhere (Avoid!)
- *Local* – Allocated only when method is executed
  - int nSum;
- *Instance* – Created for each object (Object Data)
  - private int nSum; // Access only within class methods
- *Class* – Within class's body but outside method
  - private static int nSum;
- *Parameter* – Within parenthesis of method head
  - public void setCard(String sOrder, int nRank)

Creating Objects

- Objects
  - Contains the *Instance Variables* declared in data declaration section
- Reference variable
  - Reference location for actual object's values
  - `Card oCard1;`
- `new` Dynamic Memory Allocation operator
  - For *creating an instance* or *instantiating an object*
  - `oCard1 = new Card();`
  - `Card oCard1 = new Card();` // Combined Form
- Methods
  - Provide operations that can be applied to objects
  - Object independent general-purpose functions



```java
/* Identify and Classify all Variables */
import javax.swing.*;
public class Card
{
  private String sOrder;
  private String sRank;

  public void showCard()
  {
    JOptionPane.showMessageDialog(null, sRank,
          sOrder+" Card", JOptionPane.INFORMATION_MESSAGE);
  }
  public void setCard(String sNewOrder, String sNewRank)
  {
    sOrder = sNewOrder;
    sRank = sNewRank;
  }
  public static void main(String[] args)
  {
      Card oCard1, oCard2;
      oCard1 = new Card();
      oCard2 = new Card();
      Card oCard3 = new Card();
      oCard1.setCard("1st", "4 \u2660");
      oCard2.showCard();
      oCard2.setCard("2nd", "K \u2666");
      oCard3.setCard("3rd", "A \u2665");
      oCard1.showCard();
      oCard2.showCard();
      oCard3.showCard();
      System.exit(0);
  }
}
```

null Card

1st Card

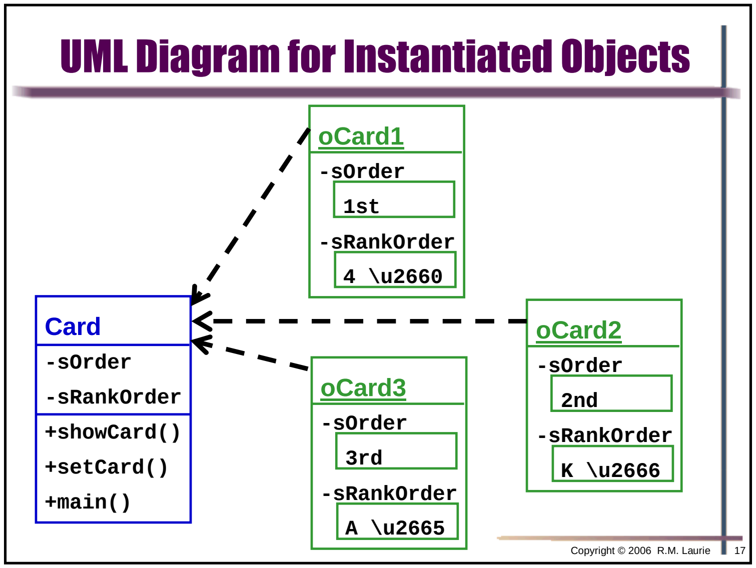
4 ♠

2nd Card

K ♦

3rd Card

A ♥



UML Diagram for Instantiated Objects

Card
-sOrder
-sRankOrder
+showCard()
+setCard()
+main()

oCard1
-sOrder
1st
-sRankOrder
4 \u2660

oCard2
-sOrder
2nd
-sRankOrder
K \u2666

oCard3
-sOrder
3rd
-sRankOrder
A \u2665

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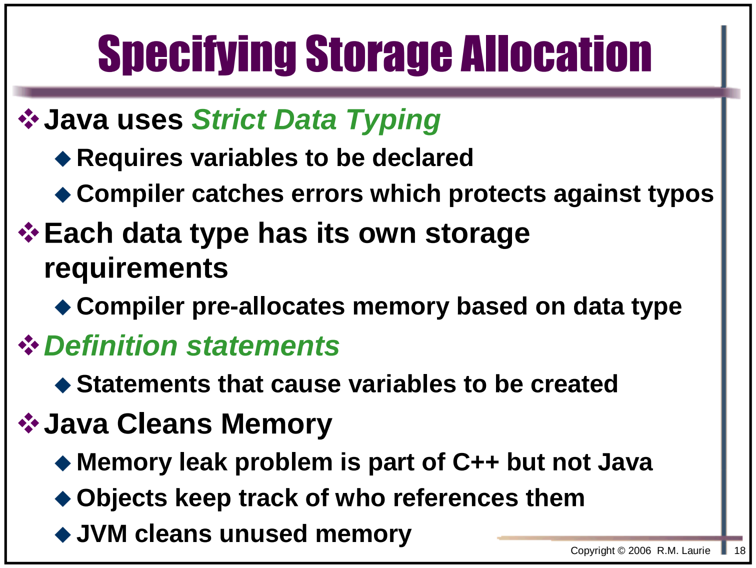

Specifying Storage Allocation

- Java uses *Strict Data Typing*
  - Requires variables to be declared
  - Compiler catches errors which protects against typos
- Each data type has its own storage requirements
  - Compiler pre-allocates memory based on data type
- *Definition statements*
  - Statements that cause variables to be created
- Java Cleans Memory
  - Memory leak problem is part of C++ but not Java
  - Objects keep track of who references them
  - JVM cleans unused memory

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