Basic Computation

Chapter 2

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Objectives

- Describe the Java data types used for simple data
- Write Java statements to declare variables, define named constants
- Write assignment statements, expressions containing variables and constants
- Define strings of characters, perform simple string processing

Objectives

- Write Java statements that accomplish keyboard input, screen output
- Adhere to stylistic guidelines and conventions
- Write meaningful comments

Outline

- Variables and Expressions
- The Class `String`
- Keyboard and Screen I/O
- Documentation and Style

Variables and Expressions: Outline

- Variables
- Data Types
- Java Identifiers
- Assignment Statements
- Simple Input
- Simple Screen Output
- Constants
- Named Constants

Variables and Expressions: Outline

- Assignment Compatibilities
- Type Casting
- Arithmetic Operations
- Parentheses and Precedence Rules
- Specialized Assignment Operators
- *Case Study:* Vending Machine Change
- Increment and Decrement Operators

Variables

- ***Variables*** store data such as numbers and letters.
  - Think of them as places to store data.
  - They are implemented as memory locations.

```
int numberOfCats = 1;
```

Variables

- The data stored by a variable is called its ***value***.
  - The value is stored in the memory location.
- Its value can be changed.

```
int numberOfCats = 2;
```

Naming and Declaring Variables

- Choose names that are helpful such as `count` or `speed`, but not `c` or `s`.
- When you *declare* a variable, you provide its name and type.

```
int numberOfBaskets,eggsPerBasket;
```

- A variable's *type* determines what kinds of values it can hold (`int`, `double`, `char`, etc.).
- A variable must be declared before it is used.

Syntax and Examples

- Syntax

  `type variable_1, variable_2, …;`

  (`variable_1` is a generic variable called a *syntactic variable*)

- Examples

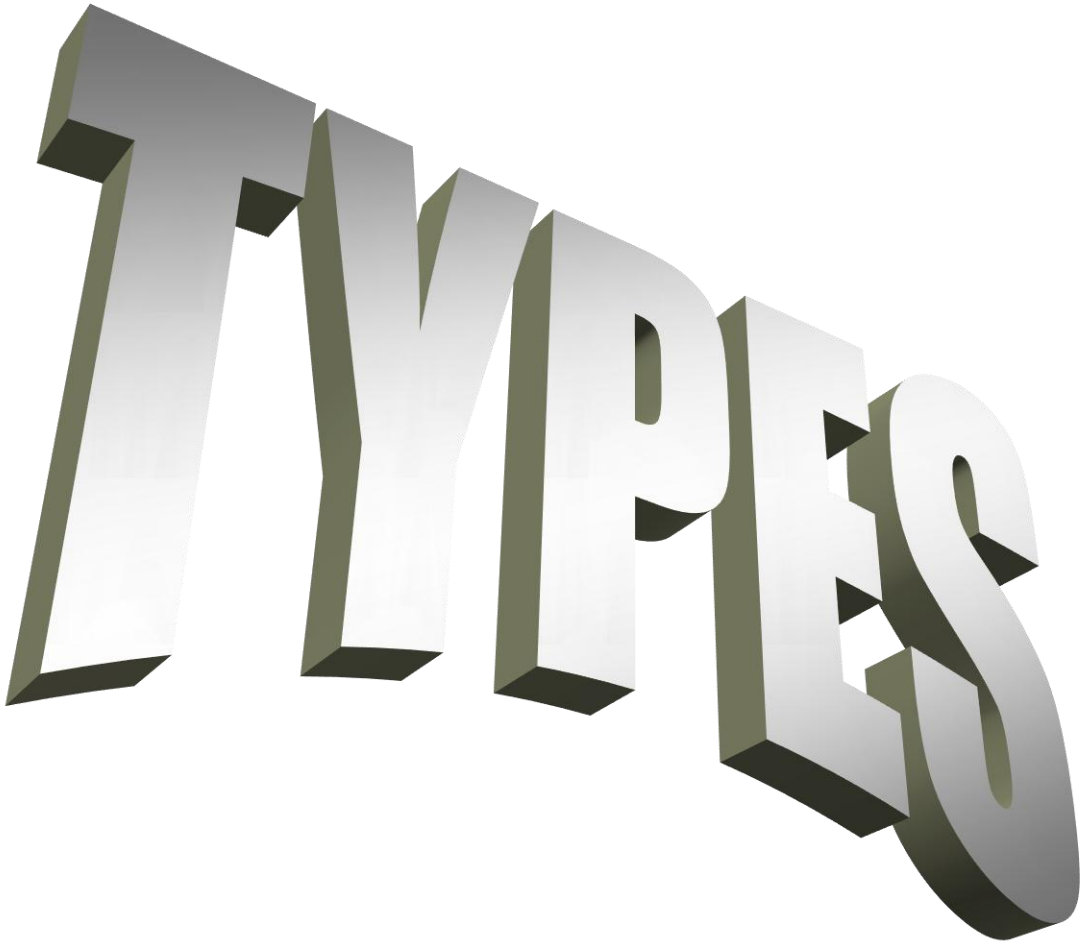
```
int styleChoice, numberOfChecks;
double balance, interestRate;
char jointOrIndividual;
```

THE BIG IDEA

- To declare variables you provide its TYPE and NAME

```
int numberOfCats;
```

- Let's look at these in more detail starting with…



Data Types

- A ***class type*** is used for a class of objects and has both data and methods.
  - `"Java is fun"` is a value of class type `String`
- A ***primitive type*** is used for simple, nondecomposable values such as an individual number or individual character.
  - `int`, `double`, and `char` are primitive types.

Primitive Types

- Four integer types (`byte`, `short`, `int`, and `long`)
  - `int` is most common
- Two floating-point types (`float` and `double`)
  - `double` is more common
- One character type (`char`)
- One boolean type (`boolean`)

Examples of Primitive Values

- Integer types

```
0   -1   365   12000
```

- Floating-point types

```
0.99   -22.8   3.14159 5.0
```

- Character type: single quotes

```
'a'   'A'   '#'   ' '
```

- Boolean type

```
true   false
```

Primitive Types

FIGURE 2.1 Primitive Type

Type Name	Kind of Value	Memory Used	Range of Values
`byte`	Integer	1 byte	–128 to 127
`short`	Integer	2 bytes	–32,768 to 32,767
`int`	Integer	4 bytes	–2,147,483,648 to 2,147,483,647
`long`	Integer	8 bytes	–9,223,372,036,8547,75,808 to 9,223,372,036,854,775,807
`float`	Floating-point	4 bytes	$\pm 3.40282347 \times 10^{+38}$ to $\pm 1.40239846 \times 10^{-45}$
`double`	Floating-point	8 bytes	$\pm 1.79769313486231570 \times 10^{+308}$ to $\pm 4.94065645841246544 \times 10^{-324}$
`char`	Single character (Unicode)	2 bytes	All Unicode values from 0 to 65,535
`boolean`		1 bit	True or false

You'll use these most often

Java Identifiers

- An ***identifier*** is a name, such as the name of a variable.
- Identifiers may contain only
  - Letters
  - Digits (0 through 9)
  - The underscore character (_)
  - And the dollar sign symbol ($) which has a special meaning
- The first character cannot be a digit.

Java Identifiers

- Identifiers may not contain any spaces, dots (`.`), asterisks (`*`), or other characters:

  `7-11` `oracle.com` `util.*` (not allowed)

- Identifiers can be arbitrarily long.
- Since Java is *case sensitive*, `stuff`, `Stuff`, and `STUFF` are different identifiers.

Keywords or Reserved Words

- Words such as `if` are called ***keywords*** or ***reserved words*** and have special, predefined meanings.
  - Cannot be used as identifiers.
  - See Appendix 1 for a complete list of Java keywords.
- Example keywords: `int`, `public`, `class`

SYNTAX

```
int class;
```

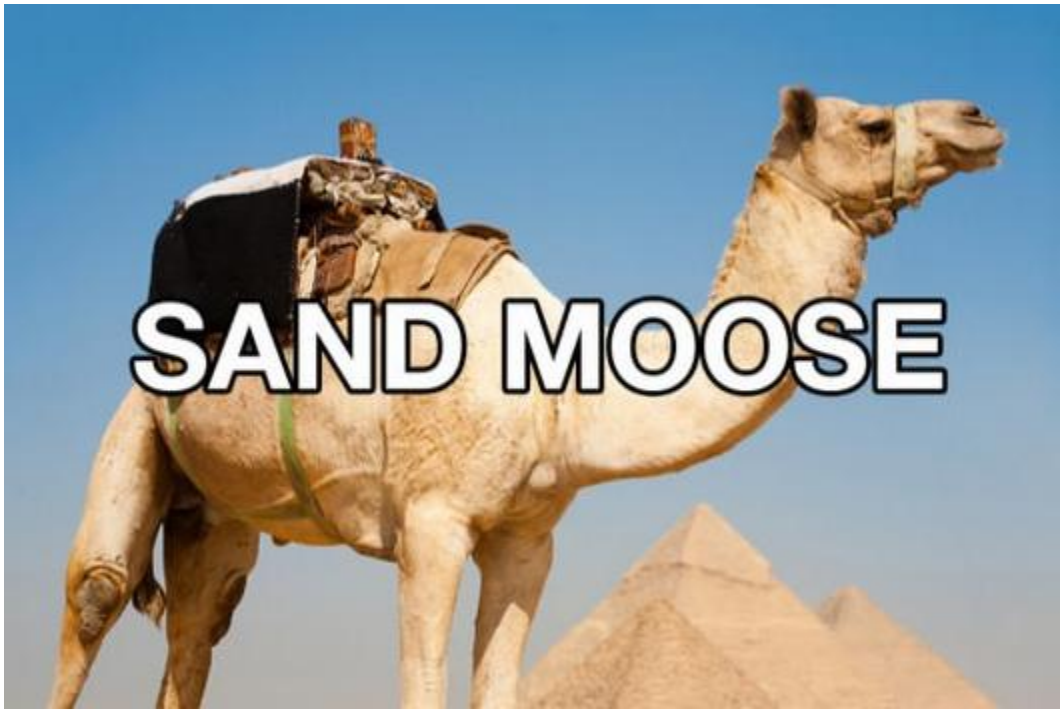
ERROR!

Naming Conventions

- Class types begin with an uppercase letter (e.g. `String`).
- Primitive types begin with a lowercase letter (e.g. `int`).
- Variables of both class and primitive types begin with a lowercase letters (e.g. `myName`, `myBalance`).
- Multiword names are "punctuated" using uppercase letters.

Naming Conventions

- The method for lower casing the first letter in the name and then uppercasing the first letter in each word is sometimes called “Camel Casing”



Where to Declare Variables

- Declare a variable
  - Just before it is used or
  - At the beginning of the section of your program that is enclosed in `{}`.

```
public static void main(String[] args)
{ /* declare variables here */
    . . .
}
```

Assignment Statements

- An assignment statement is used to assign a value to a variable.

```
answer = 42;
```

- The "equal sign" is called the *assignment operator.*
- ***It is not the same as mathematical equality.***
- *The value on the left will only be equal at the end of the statement until you change the value later.*
- We say, "The variable named `answer` is assigned a value of 42," or more simply, "`answer` is assigned 42."

Assignment Statements

- Syntax

  `variable = expression`

  where **`expression`** can be another variable, a *literal* or *constant* (such as a number), or something more complicated which combines variables and literals using *operators* (such as + and -)

The value on the left must be a variable

`2= a //BAD!`

Will raise an error

Assignment Examples

```
amount = 3.99;
firstInitial = 'W';
score = numberOfCards + handicap;
eggsPerBasket = eggsPerBasket - 2;
```

Initializing Variables

- A variable that has been declared, but no yet given a value is said to be *uninitialized.*
- Uninitialized class variables have the value `null`.
- Uninitialized primitive variables may have a default value.
- *****It's good practice not to rely on a default value.*****

Initializing Variables

- To protect against an uninitialized variable (and to keep the compiler happy), assign a value at the time the variable is declared.
- Examples:

```
int count = 0;
char grade = 'A';
```

Initializing Variables

- syntax

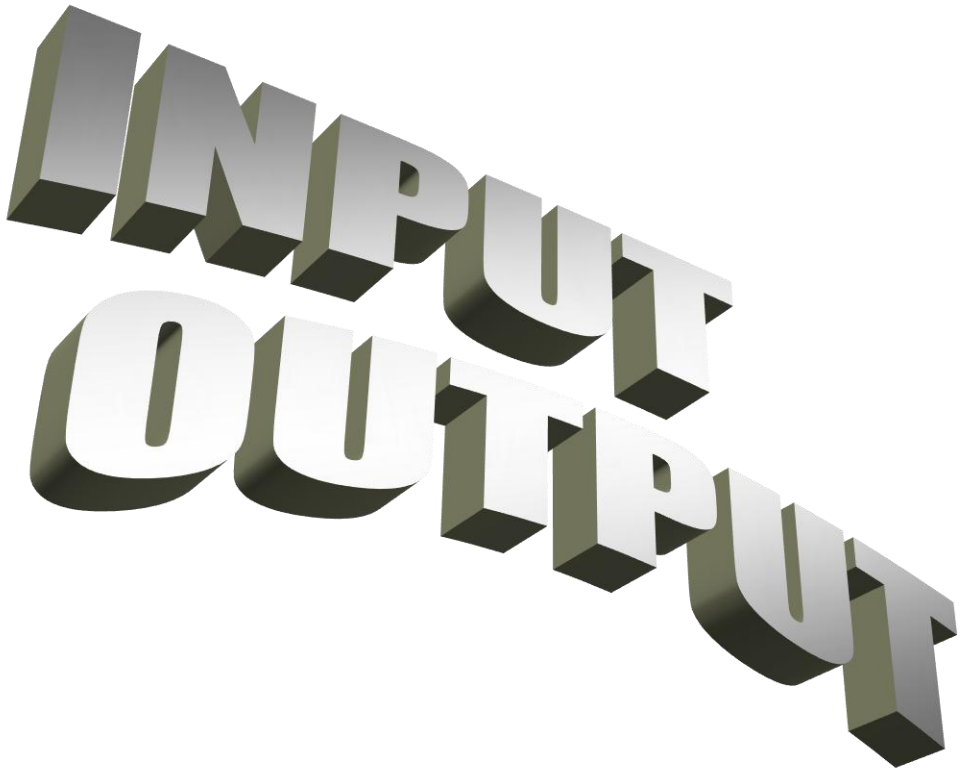
```
type variable_1 = expression_1,
variable_2 = expression_2, …;
```

```
int powerLevel = 9001;
```

Assignment Evaluation

- The expression on the right-hand side of the assignment operator (=) is evaluated first.
- The result is used to set the value of the variable on the left-hand side of the assignment operator.

```
score = numberOfCards +  handicap;
eggsPerBasket = eggsPerBasket - 2;
```



Simple Input

- Sometimes the data needed for a computation are obtained from the user at run time.
- Keyboard input requires

```
import java.util.Scanner
```

at the beginning of the file.

Simple Input

- Data can be entered from the keyboard using

```
Scanner keyboard =
    new Scanner(System.in);
```

  followed, for example, by

```
eggsPerBasket =
keyboard.nextInt();
```

  which reads one `int` value from the keyboard and assigns it to `eggsPerBasket`.

Simple Screen Output

```
System.out.println("The count is " + count);
```

- Outputs the sting literal `"the count is "`
- Followed by the current value of the variable `count`.

Constants

- Literal expressions such as `2, 3.7,` or `'y'` are called ***constants***.
- Integer constants can be preceded by a `+` or `–` sign, but cannot contain commas.
- Floating-point constants can be written
  - With digits after a decimal point or
  - Using *e notation.*

Named Constants

- Java provides mechanism to …
  - Define a variable
  - Initialize it
  - Fix the value so it cannot be changed

```
public static final Type Variable = Constant;
```

  - Example

```
public static final double PI = 3.14159;
```

e Notation

- e notation is also called *scientific notation* or *floating-point notation.*
- Examples
  - `865000000.0` can be written as `8.65e8`
  - `0.000483` can be written as `4.83e-4`
- The number in front of the `e` does not need to contain a decimal point.

Imprecision in Floating-Point Numbers

- Floating-point numbers often are only approximations since they are stored with a finite number of bits.
- Hence `1.0/3.0` is slightly less than 1/3.
- `1.0/3.0 + 1.0/3.0 + 1.0/3.0` is less than 1.

Assignment Compatibilities

- Java is said to be ***strongly typed***.
  - You can't, for example, assign a floating point value to a variable declared to store an integer.
  - When you declare a variable you must give its type
- Sometimes conversions between numbers are possible.

```
doubleVariable = 7;
```

is possible even if `doubleVariable` is of type `double`, for example.

Assignment Compatibilities

- A value of one type can be assigned to a variable of any type further to the right

```
byte --> short --> int --> long
--> float --> double
```

  - But not to a variable of any type further to the left.
- You can assign a value of type char to a variable of type `int`.

Type Casting

- A ***type cast*** temporarily changes the value of a variable from the declared type to some other type.
- For example,

```
double distance;
distance = 9.0;
int points;
points = (int)distance;
```

- Illegal without `(int)`

Type Casting

- The value of `(int)distance` is `9`,
- The value of `distance`, both before and after the cast, is `9.0`.
- Any nonzero value to the right of the decimal point is ***truncated*** rather than *rounded.*

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Arithmetic Operators

- Arithmetic expressions can be formed using the `+`, `-`, `*`, and `/` operators together with variables or numbers referred to as ***operands***.
  - When both operands are of the same type, the result is of that type.
  - When one of the operands is a floating-point type and the other is an integer, the result is a floating point type.

Arithmetic Operations

- Example

  If **`hoursWorked`** is an **`int`** to which the value **`40`** has been assigned, and **`payRate`** is a **`double`** to which **`8.25`** has been assigned

  `hoursWorked * payRate`

  is a **`double`** with a value of **`330.0`**.

Arithmetic Operations

- Expressions with two or more operators can be viewed as a series of steps, each involving only two operands.
  - The result of one step produces one of the operands to be used in the next step.
  - Regular order of operations (~PEMDAS)
- example

```
balance + (balance * rate)
```

Arithmetic Operations

- If at least one of the operands is a floating-point type and the rest are integers, the result will be a floating point type.
- The result is the rightmost type from the following list that occurs in the expression.

```
byte --> short --> int --> long
--> float --> double
```

The Division Operator

- The division operator (`/`) behaves as expected if one of the operands is a floating-point type.
- When both operands are integer types, the result is truncated, not rounded.
  - Hence, `99/100` has a value of `0`.

The `mod` Operator

- The `mod` (`%`) operator is used with operators of integer type to obtain the remainder after integer division.
- 14 divided by 4 is 3 *with a remainder of 2.*
  - Hence, `14 % 4` is equal to `2`.
- The mod operator has many uses, including
  - determining if an integer is odd or even
  - determining if one integer is evenly divisible by another integer.
  - Integer division(/) gives results without remainder and mod, next, gives remainder… together useful