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Accelerated Introduction to CS
Using Java 5

Java 5 Illuminated

An Active Learning Approach

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Chapter 2

- Programming Building Blocks
- — Java Basics

Java Syntax

- Java Syntax for Instructions
  - Keywords
  - Operators
  - Punctuations
- Java Syntax for Expressing Data
  - Keywords
  - Symbolic Names
  - Data Types

Java Basics

- Java Application Structure
- Data Types, Variables, and Constants
- Expressions and Arithmetic Operators

Java Application Structure

- All programs consist of at least one class.
- See *Example 2.1 SkeletonApplication* for standard form of Java application
- Java source code file must have the same name as class with *.java* extension.

Identifiers - Symbolic Names

- Identifiers are used to name classes, variables, and methods
- Identifier Rules:
  - Must start with a "Java letter"
    - A - Z, a - z, _, $, and Unicode letters
  - Can contain essentially any number of Java letters and digits, but no spaces
  - Case sensitive!!
    - *Number1* and *number1* are different!
  - Cannot be keywords or reserved words
    - See Appendix A

Program Building Blocks

- The Statement
  - Performs some action
  - Terminates with a semicolon (;)
  - Can span multiple lines

Building Blocks - The Block

- The Block
  - 0, 1, or more statements
  - Begins and ends with curly braces { }
  - Can be used anywhere a statement is allowed.

Building Blocks - White Space

- Space, tab, newline are white space characters
- At least one white space character is required between a keyword and identifier
- Any amount of white space characters are permitted between identifiers, keywords, operators, and literals

Building Blocks - Comments

- Comments explain the program to yourself and others
- Block comments
  - Can span several lines
  - Begin with /*
  - End with */
  - Compiler ignores all text between /* and */
- Line comments
  - Start with //
  - Compiler ignores text from // to end of line

Data Types, Variables, and Constants

- We use Symbolic Names to refer to data
- We must assign a data type for very identifier (symbolic name)
- Declaring Variables
- Primitive Data Types
- Initial Values and Literals
- String Literals and Escape Sequences
- Constants

Data Types

- For all data, assign a name (identifier) and a data type
- Data type tells compiler:
  - How much memory to allocate
  - Format in which to store data
  - Types of operations you will perform on data
- Compiler monitors use of data
  - Java is a "strongly typed" language
- Java "primitive data types"

  byte, short, int, long, float, double, char, boolean

Declaring Variables

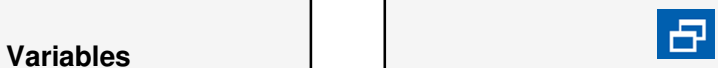
- Every Variable must be given a name and a data type
- Variables hold one value at a time, but that value can change
- Syntax:

```
dataType identifier;
```

or

```
dataType identifier1, identifier2, …;
```

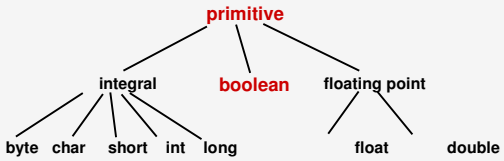
- Naming convention for variable names:
  - first letter is lowercase
  - embedded words begin with uppercase letter



- Names of variables should be meaningful and reflect the data they will store
  - This makes the logic of the program clearer
- Don't skimp on characters, but avoid extremely long names
- Avoid names similar to Java keywords

Java Primitive Data Types

- **byte, short, int, long , float, double, char, boolean**



Integer Types - Whole Numbers

Type	Size in Bytes	Minimum Value	Maximum Value
byte	1	-128	127
short	2	-32,768	32,767
int	4	-2, 147, 483, 648	2, 147, 483, 647
long	8	-9,223,372,036,854,775,808	9,223,372,036,854,775,807

Example declarations:

```
int testGrade;
int numPlayers, highScore, diceRoll;
short  xCoordinate, yCoordinate;
byte ageInYears;
long cityPopulation;
```


Floating-Point Data Types

- Numbers with fractional parts

Type	Size in Bytes	Minimum Value	Maximum Value
float	4	1.4E-45	3.4028235E38
double	8	4.9E-324	1.7976931348623157E308

Example declarations:

```
float salesTax;
double interestRate;
double paycheck, sumSalaries;
```


char Data Type

- One Unicode character (16 bits - 2 bytes)

Type	Size in Bytes	Minimum Value	Maximum Value
char	2	character encoded as 0	character encoded as FFFF

Example declarations:

```
char finalGrade;
char newline, tab, doubleQuotes;
```

boolean Data Type

- Two values only:
  - `true`
  - `false`
- Used for decision making or as "flag" variables
- Example declarations:

```
boolean isEmpty;
boolean passed, failed;
```


Assigning Values to Variables

- Assignment operator =
  - Value on the right of the operator is assigned to the variable on the left
  - Value on the right can be a literal (text representing a specific value), another variable, or an **expression** (explained later)
- Syntax:

```
dataType variableName = initialValue;
```

Or

```
dataType variable1 = initialValue1,
         variable2 = initialValue2, …;
```


Literals

- ***int, short, byte***

Optional initial sign (+ or -) followed by digits 0 – 9 in any combination.

```
int testGrade = 100;
```

- ***long***

Optional initial sign (+ or -) followed by digits 0– 9 in any combination, terminated with an *L* or *l*.

***Use the capital *L* because the lowercase *l* can be confused with the number *1*.

Floating-Point Literals

- ***float***

Optional initial sign (+ or -) followed by a floating-point number in fixed or scientific format, terminated by an *F* or *f*.

- ***double***

Optional initial sign (+ or -) followed by a floating-point number in fixed or scientific format.

char and *boolean* Literals

- *char*
  - Any printable character enclosed in single quotes
  - A decimal value from 0 – 65535
  - '\m' , where \m is an escape sequence. For example, *'\n'* represents a newline, and *'\t'* represents a tab character.
- *boolean*

`true` or `false`

See Example 2.2 Variables.java

Assigning the Values of Other Variables

- Syntax:

```
dataType variable2 = variable1;
```

- Rules:

1. *variable1* needs to be defined before this statement appears in the source code

2. *variable1* and *variable2* need to be compatible data types; in other words, the precision of *variable1* must be lower than or equal to that of *variable2*.

Compatible Data Types

Any type in right column can be assigned to type in left column:

Data Type	Compatible Data Types
byte	*byte*
short	*byte, short*
int	*byte, short, int, char*
long	*byte, short, int, long, char*
float	*float, byte, short, int, long, char*
double	*float, double, byte, short, int, long, char*
boolean	*boolean*
char	*char*

Sample Assignments

- This is a valid assignment:

```
float salesTax = .05f;
double taxRate = salesTax;
```

- This is invalid because the *float* data type is lower in precision than the *double* data type:

```
double taxRate = .05;
float salesTax = taxRate;
```


String Literals

- *String* is actually a class, not a basic data type; *String* variables are objects
- *String* literal: text contained within double quotes
- Example of *String* literals:

```
"Hello"
"Hello world"
"The value of x is "
```


String Concatenation Operator (+)

- Combines *String* literals with other data types for printing
- Example:

```
String hello = "Hello";
String there = "there";
String greeting = hello + ' ' + there;
System.out.println( greeting );
```

Output is:

```
Hello there
```


Common Error Trap

- *String* literals must start and end on the same line. This statement:

```
System.out.println( "Never pass a water fountain
            without taking a drink" );
```

generates these compiler errors:

```
unclosed string literal
')' expected
```

- Break long *Strings* into shorter *Strings* and use the concatenation operator:

```
System.out.println( "Never pass a water fountain"
         +  " without taking a drink" );
```


Escape Sequences

- **To include a special character in a *String*, use an escape sequence**

Character	Escape Sequence
Newline	\n
Tab	\t
Double quotes	\"
Single quote	\'
Backslash	\\
Backspace	\b
Carriage return	\r
Form feed	\f

See *Example 2.3 Literals.java*

- Declare a variable only once
- Once a variable is declared, its data type cannot be changed.

These statements:

```
double twoCents;
double twoCents = .02;
```

generate this compiler error:

```
twoCents is already defined
```


- Once a variable is declared, its data type cannot be changed.

These statements:

```
double cashInHand;
int cashInHand;
```

generate this compiler error:

```
cashInHand is already defined
```


Constants

- Value cannot change during program execution
- Syntax:

```
final dataType constantIdentifier =
                          assignedValue;
```

Note: assigning a value when the constant is declared is optional. But a value must be assigned before the constant is used.

- *See Example 2.4 Constants.java*

- Use all capital letters for constants and separate words with an underscore:

Example:

```
final double TAX_RATE = .05;
```

- Declare constants at the top of the program so their values can easily be seen
- Declare as a constant any data that should not change during program execution

Expressions and Arithmetic Operators

- The Assignment Operator and Expressions
- Arithmetic Operators
- Operator Precedence
- Integer Division and Modulus
- Division by Zero
- Mixed-Type Arithmetic and Type Casting
- Shortcut Operators

Assignment Operator

Syntax:

```
target = expression;
```

expression: operators and operands that evaluate to a single value

--value is then assigned to target

--target must be a variable (or constant)

--value must be compatible with target's data type

Examples: Assignment

```
int numPlayers = 10; // numPlayers holds 10
numPlayers = 8;      // numPlayers now holds 8

int legalAge = 18;
int voterAge = legalAge;
```

The next statement is illegal

```
int height = weight * 2; // weight is not defined
int weight = 20;
```

and generates the following compiler error:

```
  illegal forward reference
```


Arithmetic Operators

Operator	Operation
+	addition
-	subtraction
*	multiplication
/	division
%	modulus (remainder after division)

Example

- *See Example 2.7 SimpleOperators.java Page 65*

Operator Precedence

Operator	Order of evaluation	Operation
( )	left - right	parenthesis for explicit grouping
* / %	left - right	multiplication, division, modulus
+ -	left - right	addition, subtraction
=	right - left	assignment

Example

You have 2 quarters, 3 dimes, and 2 nickels.
How many pennies are these coins worth?

```
int pennies = 2 * 25 + 3 * 10 + 2 * 5;
            =   50   +   30   + 10
            =  90
```


Another Example

Translate $\frac{x}{2y}$ into Java:

```
// incorrect!
double result = x / 2 * y;
```

=> $\frac{x}{2} * y$

```
// correct
double result = x / ( 2 * y );
```

Integer Division & Modulus

- When dividing two integers:
  - the quotient is an integer
  - the remainder is truncated (discarded)
- To get the remainder, use the modulus operator with the same operands
- ***See Example 2.8 DivisionAndModulus.java***

Division by Zero

- Integer division by 0:

  Example: `int result = 4 / 0;`
- No compiler error, but at run time, JVM generates *ArithmeticException* and program stops executing
- Floating-point division by 0:
  - If dividend is not 0, the result is *Infinity*
  - If dividend and divisor are both 0, the result is *NaN* (not a number)
- ***See Example 2.9 DivisionByZero.java***

Mixed-Type Arithmetic

- When performing calculations with operands of different data types:
  - Lower-precision operands are promoted to higher-precision data types, then the operation is performed
  - Promotion is effective only for expression evaluation; not a permanent change
  - Called "implicit type casting"
- Bottom line: any expression involving a floating-point operand will have a floating-point result.

Rules of Promotion

Applies the first of these rules that fits:

1. If either operand is a ***double***, the other operand is converted to a *double*.
2. If either operand is a ***float***, the other operand is converted to a *float*.
3. If either operand is a ***long***, the other operand is converted to a *long*.
4. If either operand is an ***int***, the other operand is promoted to an *int*
5. If neither operand is a *double*, *float*, *long*, or an *int*, both operands are promoted to ***int***.

Explicit Type Casting

- Syntax:

  `(dataType)( expression )`

  Note: parentheses around expression are optional if expression consists of 1 variable
- Useful for calculating averages
- ***See Example 2.10, MixedDataTypes.java***

Shortcut Operators

`++` increment by 1 `--` decrement by 1

Example:

```
count++;    // count = count + 1;
count--;    // count = count - 1;
```

Postfix version (`var++, var--`): use value of *var* in expression, then increment or decrement.

Prefix version (`++var, --var`): increment or decrement *var*, then use value in expression

See Example 2.11 ShortcutOperators

More Shortcut Operators

Operator	Example	Equivalent
+=	a += 3;	a = a + 3;
-=	a -= 10;	a = a - 10;
*=	a *= 4;	a = a * 4;
/=	a /= 7;	a = a / 7;
%=	a %= 10;	a = a % 10;

Common Error Trap

- No spaces are allowed between the arithmetic operator and the equals sign
- Note that the correct sequence is +=, not =+

Example: add 2 to a

```
// incorrect
a =+ 2; //   a = +2; assigns 2 to 2

// correct
a += 2;   // a = a + 2;
```


Operator Precedence

Operator	Order of evaluation	Operation
( )	left - right	parenthesis for explicit grouping
++ --	right - left	preincrement, predecrement
++ --	right - left	postincrement, postdecrement
* / %	left - right	multiplication, division, modulus
+ -	left - right	addition or *String* concatenation, subtraction
= += -= *= /= %=	right - left	assignment