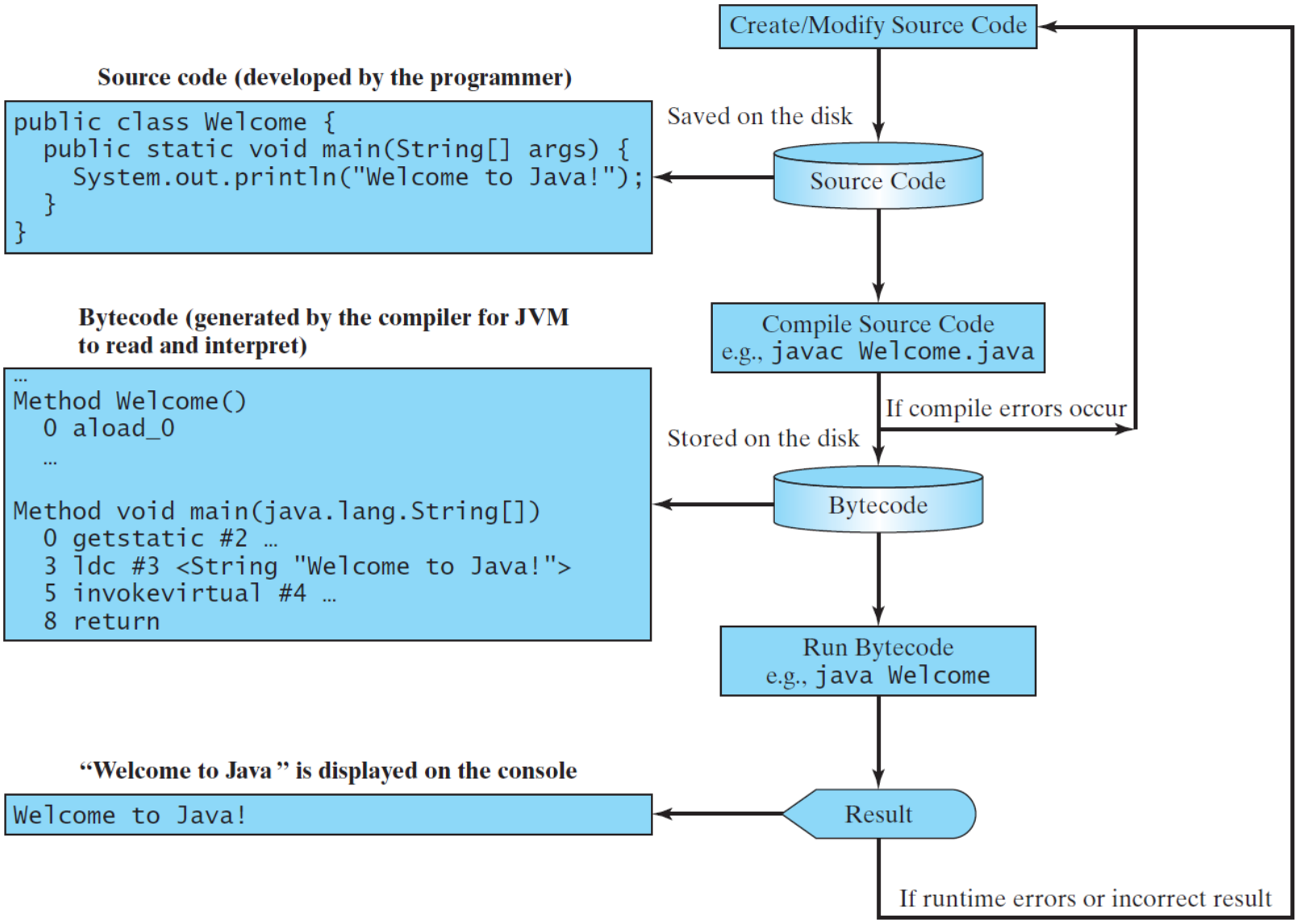
Lecture 2

Program execution, variables, control flow, io

Creating, Compiling, and Running Programs



Anatomy of a Java Program

- Class name
- Main method
- Statements
- Statement terminator
- Reserved words
- Comments
- Blocks

Class Name

- Every Java program must have at least **one class**.
- Each class has a name.
- By convention, class names start with an uppercase letter.
- The class name **must** coincide with the file name (case sensitive).

```
// This program prints Welcome to Java!
public class Welcome {
  public static void main(String[] args) {
    System.out.println("Welcome to Java!");
  }
}
```

Main Method

- Line 2 defines the main method.
- In order to run a class, the class must contain a method named main.
- The program is executed from the main method.

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// This program prints Welcome to Java!
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}
```

Statement

- A statement represents an action or a sequence of actions.
- The statement `System.out.println("Welcome to Java!")` displays "Welcome to Java!".

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  }
}
```

Statement Terminator

- Every statement in Java ends with a semicolon ;

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  public static void main(String[] args) {
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  }
}
```

Reserved words

- Reserved words or keywords are words that have a specific meaning to the compiler and cannot be used for other purposes in the program.
- For example, when the compiler sees the word class, it understands that the word after class is the name for the class.

```
// This program prints Welcome to Java!
public class Welcome {
  public static void main(String[] args) {
    System.out.println("Welcome to Java!");
  }
}
```

Blocks

- A pair of braces in a program forms a block that groups components of a program.
- Equivalent to tabs in python

```
// This program prints Welcome to Java!
public class Welcome {
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```

Special Symbols

Character	Name	Description
{}	Opening and closing braces	Denotes a block to enclose statements.
()	Opening and closing parentheses	Used with methods.
[]	Opening and closing brackets	Denotes an array.
//	Double slashes	Precedes a comment line.
" "	Opening and closing quotation marks	Enclosing a string (i.e., sequence of characters).
;	Semicolon	Marks the end of a statement.

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}
```

Programming Style and Documentation

- Appropriate Comments
  - Include a summary at the beginning of the program to explain what the program does, its key features, its supporting data structures, and any unique techniques it uses.
  - Include your name, class section, instructor, date, and a brief description at the beginning of the program.
- Naming Conventions
  - Choose meaningful and descriptive names
  - Use CamelCase for class names
- Proper Indentation and Spacing Lines
  - Indent the code like python
  - Use blank line to separate segments of the code
- Block Styles
  - Next line
  - End of line

Trace a Program Execution

```
// This program prints Welcome to Java!
public class Welcome {
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    System.out.println("Welcome to Java!");
  }
}
```
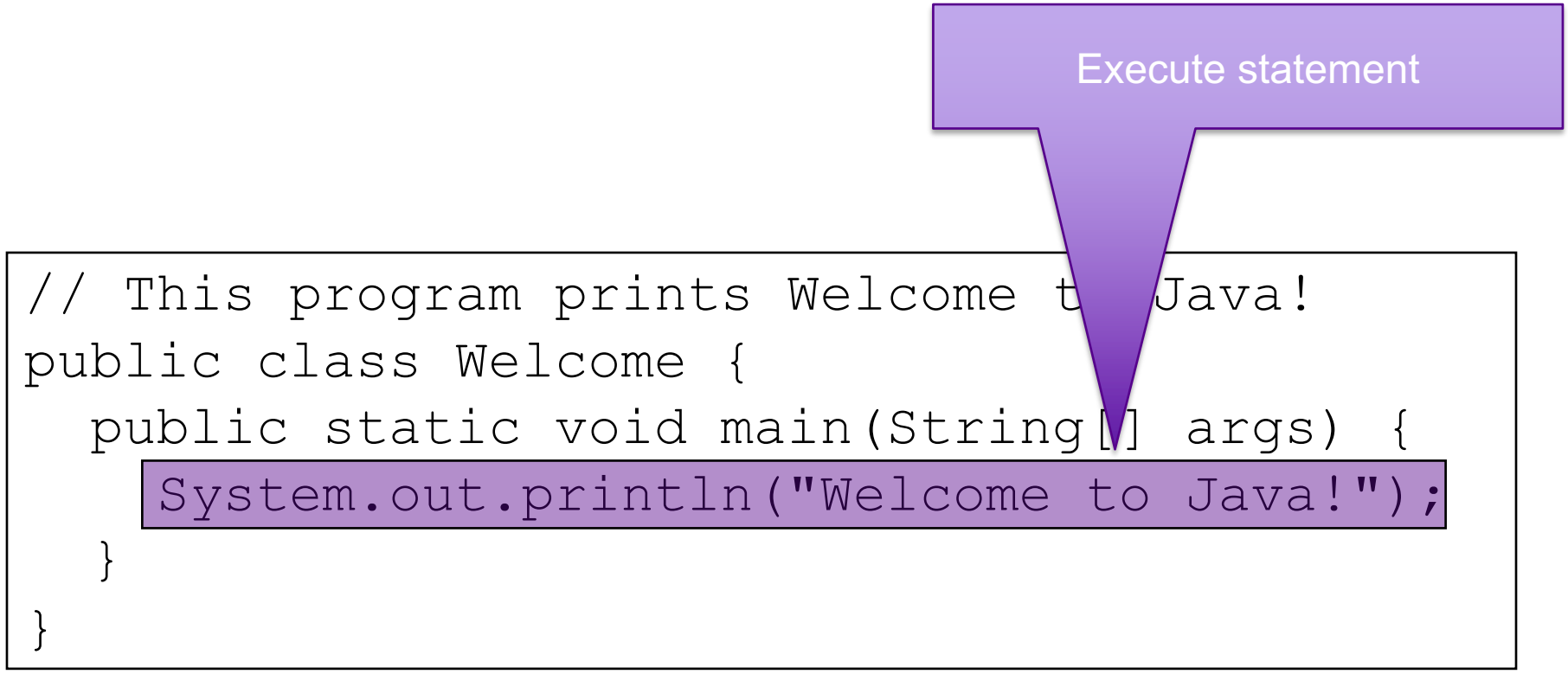

Trace a Program Execution

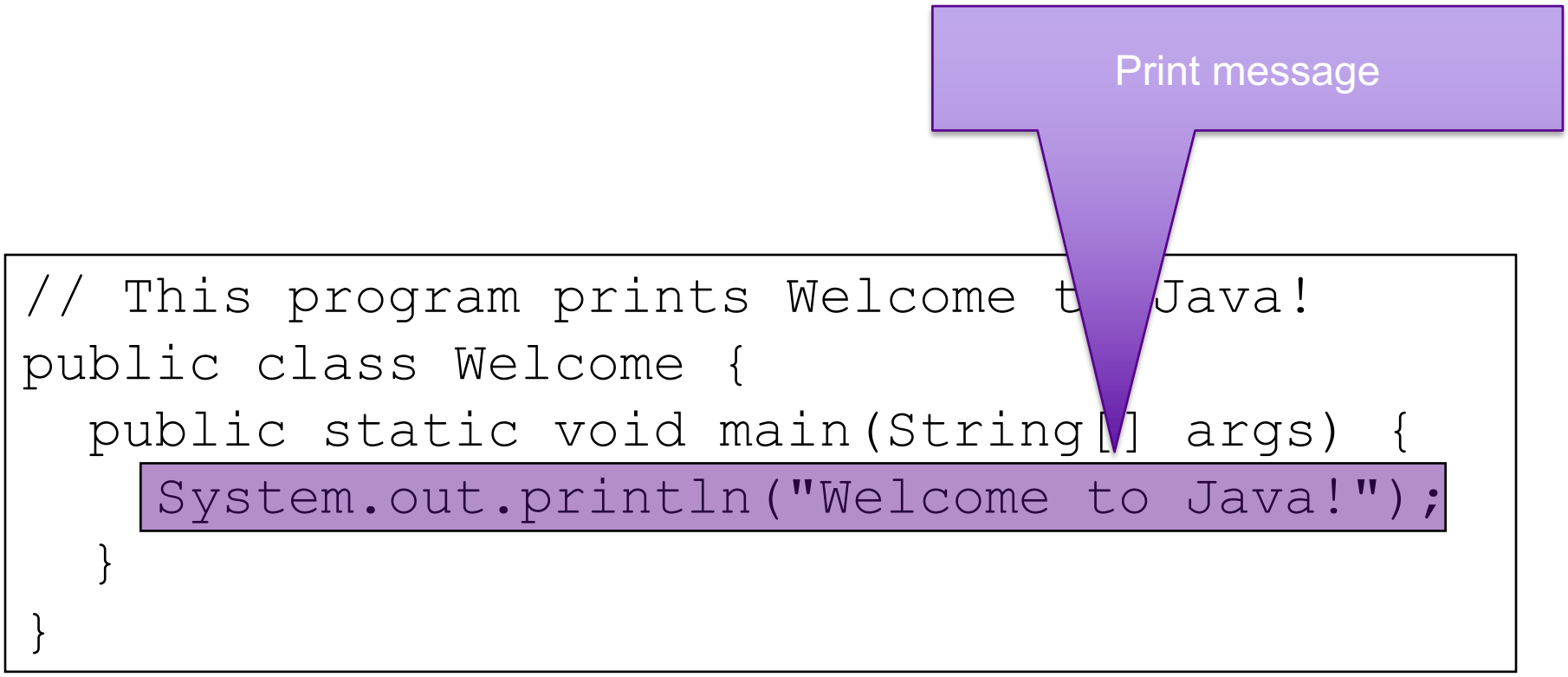
Enter main method

```
// This program prints Welcome to Java!
public class Welcome {
  public static void main(String[] args) {
    System.out.println("Welcome to Java!");
  }
}
```

Trace a Program Execution



Trace a Program Execution



Programming Errors

- Syntax Errors
  - Detected by the compiler
- Runtime Errors
  - Causes the program to abort
- Logic Errors
  - Produces incorrect result

Syntax Errors

```
// This program contains errors
public class ShowSyntaxErrors {
  public static main(String[] args) {
    System.out.println("Welcome to Java);
  }
}
```

Runtime Errors

```
// This program contains errors
public class ShowRuntimeErrors {
  public static void main(String[] args) {
    System.out.println(1 / 0);
  }
}
```

Logic Errors

```
// This program contains errors
public class ShowLogicErrors {
  public static void main(String[] args) {
    System.out.println("Celsius 35 is
  Fahrenheit degree ");
    System.out.println((9 / 5) * 35 + 32);
  }
}
```

Variables

- Declaring
  - `int x;` // Declare x to be an integer variable;
  - `double radius;` // Declare radius to be a double variable;
  - `char a;` // Declare a to be a character variable;
- Assign
  - `x = 1;` // Assign 1 to x;
  - `radius = 1.0;` // Assign 1.0 to radius;
  - `a = 'A';` // Assign 'A' to a;
- Constants
  - `final double PI = 3.14159;`
  - `final int SIZE = 3;`
- Declaring and initializing in one step
  - `int x = 1;`
  - `double d = 1.4;`

Variable names AKA Identifiers

- An identifier is a sequence of characters that consist of letters, digits, underscores (_), and dollar signs ($).
- An identifier must start with a letter, an underscore (_), or a dollar sign ($). It cannot start with a digit.
- An identifier cannot be a reserved word.
- An identifier cannot be true, false, or null.
- An identifier can be of any length.

- Naming conventions
  - Choose meaningful and descriptive names.
  - Use lowercase. If the name consists of several words, use camelCase
  - Constants, capitalize all letters, and use underscores to connect words.

Types

Name	Range	Storage Size
`byte`	-2^7 to $2^7 - 1$ (-128 to 127)	8-bit signed
`short`	-2^{15} to $2^{15} - 1$ (-32768 to 32767)	16-bit signed
`int`	-2^{31} to $2^{31} - 1$ (-2147483648 to 2147483647)	32-bit signed
`long`	-2^{63} to $2^{63} - 1$ (i.e., -9223372036854775808 to 9223372036854775807)	64-bit signed
`float`	Negative range: -3.4028235E+38 to -1.4E-45 Positive range: 1.4E-45 to 3.4028235E+38	32-bit IEEE 754
`double`	Negative range: -1.7976931348623157E+308 to -4.9E-324 Positive range: 4.9E-324 to 1.7976931348623157E+308	64-bit IEEE 754

Numeric Operators

Name	Meaning	Example	Result
+	Addition	34 + 1	35
-	Subtraction	34.0 - 0.1	33.9
*	Multiplication	300 * 30	9000
/	Division	1.0 / 2.0	0.5
%	Remainder	20 % 3	2

Augmented Assignment Operators

Operator	*Name*	*Example*	*Equivalent*
`+=`	Addition assignment	`i += 8`	`i = i + 8`
`-=`	Subtraction assignment	`i -= 8`	`i = i - 8`
`*=`	Multiplication assignment	`i *= 8`	`i = i * 8`
`/=`	Division assignment	`i /= 8`	`i = i / 8`
`%=`	Remainder assignment	`i %= 8`	`i = i % 8`

Increment and Decrement Operators

Operator	*Name*	*Description*	*Example (assume i = 1)*
`++var`	preincrement	Increment `var` by `1`, and use the new `var` value in the statement	`int j = ++i;` `// j is 2, i is 2`
`var++`	postincrement	Increment `var` by `1`, but use the original `var` value in the statement	`int j = i++;` `// j is 1, i is 2`
`--var`	predecrement	Decrement `var` by `1`, and use the new `var` value in the statement	`int j = --i;` `// j is 0, i is 0`
`var--`	postdecrement	Decrement `var` by `1`, and use the original `var` value in the statement	`int j = i--;` `// j is 1, i is 0`

Increment and Decrement Operators, cont.

```
int i = 10;
int newNum = 10 * i++;
```

Same effect as

```
int newNum = 10 * i;
i = i + 1;
```

```
int i = 10;
int newNum = 10 * (++i);
```

Same effect as

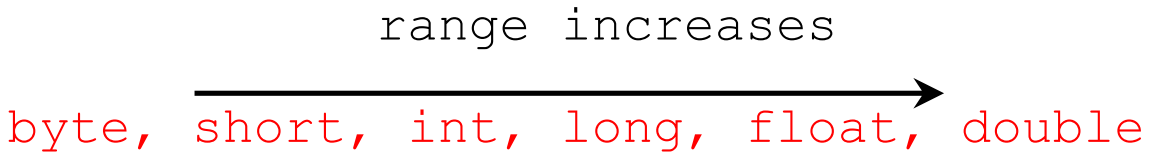
```
i = i + 1;
int newNum = 10 * i;
```

- Using increment and decrement operators makes expressions short, but it also makes them complex and difficult to read.
- Avoid using these operators in expressions that modify multiple variables, or the same variable for multiple times such as this
- `int k = ++i + i`

Conversion Rules

- When performing a binary operation involving two operands of different types, Java automatically converts the operand based on the following rules:
  - If one of the operands is double, the other is converted into double.
  - Otherwise, if one of the operands is float, the other is converted into float.
  - Otherwise, if one of the operands is long, the other is converted into long.
  - Otherwise, both operands are converted into int.

- Implicit casting
  - `double d = 3;` (type widening)
- Explicit casting
  - `int i = (int)3.0;` (type narrowing)
  - `int i = (int)3.9;` (Fraction part is truncated)



Common Errors and Pitfalls

- Undeclared/Uninitialized Variables and Unused Variables

```
double interestRate = 0.05;
double interest = interestrate * 45;
```

- Integer Overflow

```
int value = 2147483647 + 1;// value will be -2147483648
```

- Round-off Errors

```
System.out.println(1.0 - 0.9);  //prints 0.09999999999999998
```

- Unintended Integer Division

```
int number1 = 1;
int number2 = 2;
double average = (number1 + number2) / 2;

int number1 = 1;
int number2 = 2;
double average = (number1 + number2) / 2.0;
```

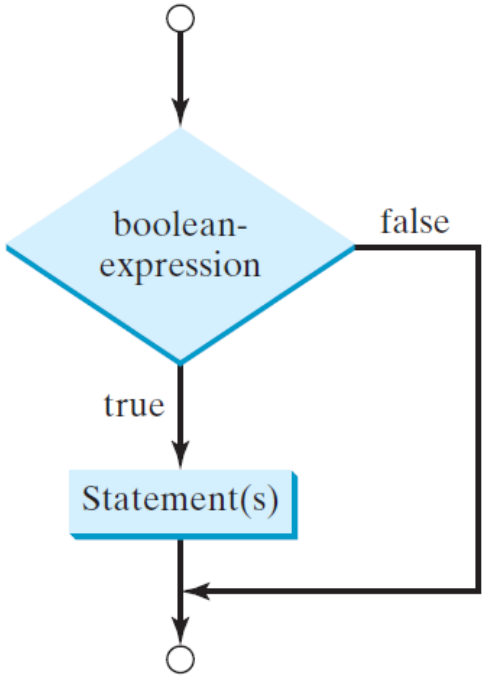
The boolean Type and Operators

- Often in a program you need to compare two values, such as whether i is greater than j. Java provides six comparison operators (also known as relational operators) that can be used to compare two values. The result of the comparison is a Boolean value: true or false.
- boolean b = (1 > 2);

Java Operator	Mathematics Symbol	Name	Example (radius is 5)	Result
`<`	<	less than	`radius < 0`	`false`
`<=`	≤	less than or equal to	`radius <= 0`	`false`
`>`	>	greater than	`radius > 0`	`true`
`>=`	≥	greater than or equal to	`radius >= 0`	`true`
`==`	=	equal to	`radius == 0`	`false`
`!=`	≠	not equal to	`radius != 0`	`true`

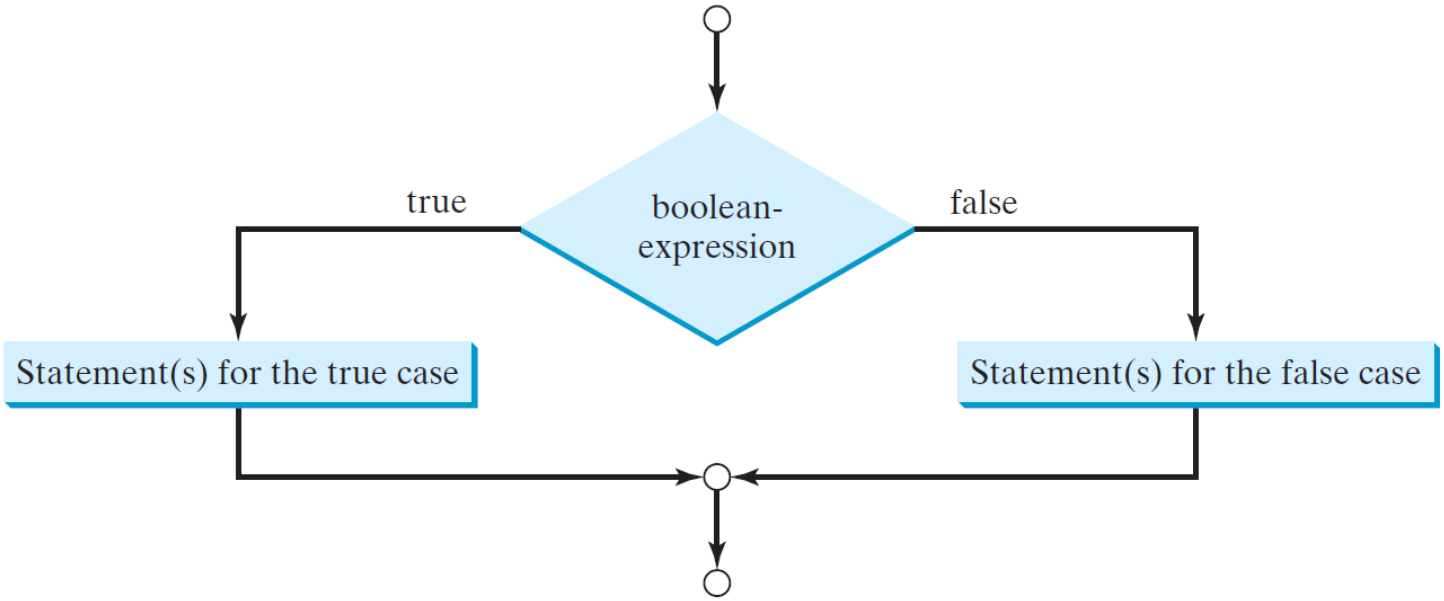
One-way if Statements

```
if (boolean-expression) {
  statement(s);
}
```



Two-way if Statements

```
if (boolean-expression) {
 statement(s)-for-the-true-case;
}
else {
 statement(s)-for-the-false-case;
}
```



if-else Example

```
if (radius >= 0) {
 area = radius * radius * 3.14159;
 System.out.println("The area is " + area);
}
else {
  System.out.println("Negative input");
}
```

```
if (score >= 90.0)
  System.out.print("A");
else
  if (score >= 80.0)
    System.out.print("B");
  else
    if (score >= 70.0)
      System.out.print("C");
    else
      if (score >= 60.0)
        System.out.print("D");
      else
        System.out.print("F");
```

=

```
if (score >= 90.0)
  System.out.print("A");
else if (score >= 80.0)
  System.out.print("B");
else if (score >= 70.0)
  System.out.print("C");
else if (score >= 60.0)
  System.out.print("D");
else
  System.out.print("F");
```

switch Statements

```
switch (status) {
  case 0:  statemet-for-0;
           break;
  case 1:  statemet-for-1;
           break;
  case 2:  statemet-for-2;
           break;
  case 3:  statemet-for-3;
           break;
  default: statemet-for-1-3;
}
```

Operator Precedence

1. var++, var--
2. +, - (Unary plus and minus), ++var,--var
3. (type) Casting
4. ! (Not)
5. *, /, % (Multiplication, division, and remainder)
6. +, - (Binary addition and subtraction)
7. <, <=, >, >= (Relational operators)
8. ==, !=; (Equality)
9. ^ (Exclusive OR)
10. && (Conditional AND) Short-circuit AND
11. || (Conditional OR) Short-circuit OR
12. =, +=, -=, *=, /=, %= (Assignment operator)

Reading Input from the Console

- Create a Scanner object

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

- Use a method to obtain to a value.

Method	Description
`nextByte()`	reads an integer of the `byte` type.
`nextShort()`	reads an integer of the `short` type.
`nextInt()`	reads an integer of the `int` type.
`nextLong()`	reads an integer of the `long` type.
`nextFloat()`	reads a number of the `float` type.
`nextDouble()`	reads a number of the `double` type.

- Example

```
Scanner input = new Scanner(System.in);
int value = input.nextInt();
```

Common Pitfall: Redundant Input Objects

```
Scanner input = new Scanner(System.in);
System.out.print("Enter an integer: ");
int v1 = input.nextInt();

Scanner input1 = new Scanner(System.in);
System.out.print("Enter a double value: ");
double v2 = input1.nextDouble();
```