BIRZEIT UNIVERSITY

COMPUTER SCIENCE DEPARTMENT FACULTY
OF ENGINEERING AND TECHNOLOGY
ADVANCED PROGRAMMING COMP231

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# Chapter 3 Selections



## 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);
```



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# Relational Operators

| 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 |




# Problem: A Simple Math Learning Tool

This example creates a program to let a first grader practice additions. The program randomly generates two single-digit integers number1 and number2 and displays a question such as "What is 7 + 9?" to the student. After the student types the answer, the program displays a message to indicate whether the answer is true or false.

IMPORTANT NOTE: If you cannot run the buttons, see liveexample.pearsoncmg.com/slide/javaslidenote.doc

AdditionQuiz Run




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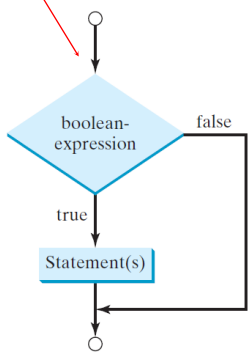
```
import java.util.Scanner;
public class AdditionQuiz {

        public static void main(String[] args) {
                int number1 = (int)(System.currentTimeMillis() % 10);
                int number2 = (int)(System.currentTimeMillis() / 10 % 10);
              // Create a Scanner Scanner input = new Scanner(System.in);
              System.out.print( "What is " + number1 + " + " + number2 + "? ");
             int answer = input.nextInt();
           System.out.println( number1 + " + " + number2 + " = " + answer +
            " is " + (number1 + number2 == answer));
    }

}
```

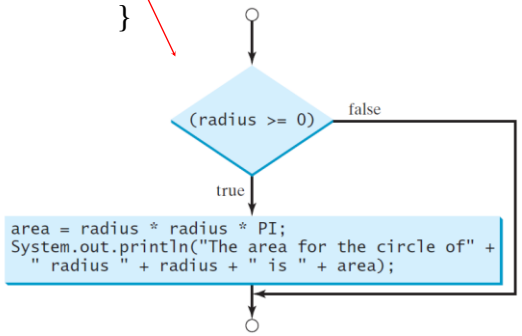


# One-way `if` Statements

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




```
if (radius >= 0) {
  area = radius * radius * PI;
  System.out.println("The area"
    + " for the circle of radius "
    + radius + " is " + area);
}
```



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# Note

```
if i > 0 {
   System.out.println("i is positive");
}
```

(a) Wrong

```
if (i > 0) {
   System.out.println("i is positive");
}
```

(b) Correct

```
if (i > 0) {
   System.out.println("i is positive");
}
```

(a)

Equivalent

```
if (i > 0)
   System.out.println("i is positive");
```

(b)



# Simple if Demo

Write a program that prompts the user to enter an integer. If the number is a multiple of 5, print HiFive. If the number is divisible by 2, print HiEven.

```
import java.util.Scanner;
public class SimpleIfDemo {
    public static void main(String[] args) {
       Scanner input = new Scanner(System.in);
       System.out.print("Enter an integer: "); int number = input.nextInt();
    if (number % 5 == 0)
      System.out.println("HiFive");
     if (number % 2 == 0)
  System.out.println("HiEven");
  }
 }
```



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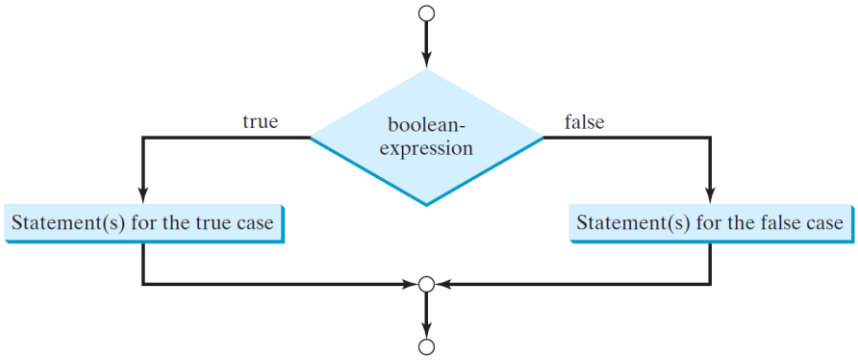
# The Two-way `if` Statement

```
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 for the "
    + "circle of radius " + radius +
    " is " + area);
}
else {
  System.out.println("Negative input");
}
```



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# Multiple Alternative if Statements

```
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");
```

(a)

Equivalent

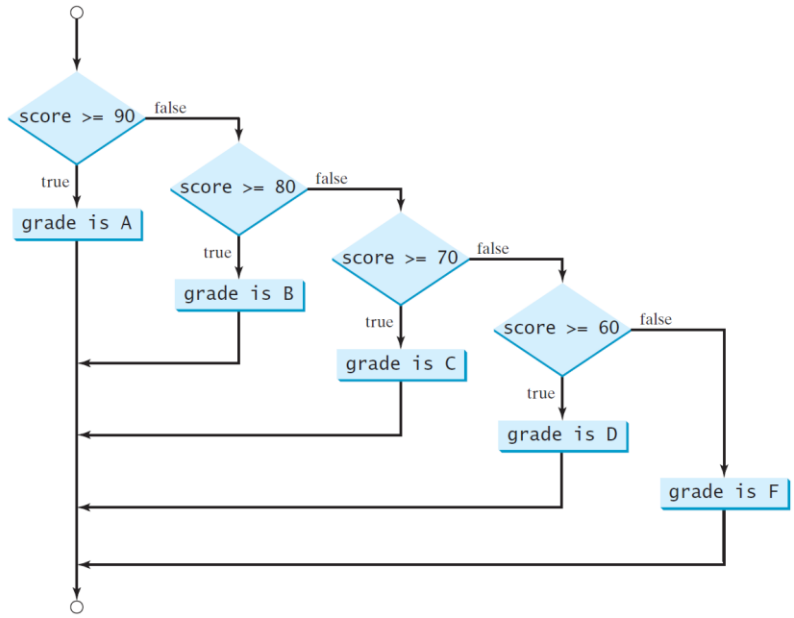
This is better

```
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");
```

(b)



# Multi-Way if-else Statements



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# Note

The else clause matches the most recent if clause in the same block.

```
int i = 1, j = 2, k = 3;

if (i > j)
  if (i > k)
    System.out.println("A");
else
    System.out.println("B");
```

(a)

Equivalent

This is better with correct indentation

```
int i = 1, j = 2, k = 3;

if (i > j)
  if (i > k)
    System.out.println("A");
  else
    System.out.println("B");
```

(b)



# Note, cont.

Nothing is printed from the preceding statement. To force the else clause to match the first if clause, you must add a pair of braces:

```
int i = 1;
int j = 2;
int k = 3;
if (i > j) {
  if (i > k)
    System.out.println("A");
}
else
  System.out.println("B");
```

This statement prints B.



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# Common Errors

Adding a semicolon at the end of an if clause is a common mistake.

```
if (radius >= 0);
{
  area = radius*radius*PI;
  System.out.println(
    "The area for the circle of radius " +
    radius + " is " + area);
}
```

Wrong

This mistake is hard to find, because it is not a compilation error or a runtime error, it is a logic error.

This error often occurs when you use the next-line block style.



# TIP

```
if (number % 2 == 0)
  even = true;
else
  even = false;
```

(a)

Equivalent

```
boolean even
  = number % 2 == 0;
```

(b)



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# CAUTION

```
if (even == true)
  System.out.println(
    "It is even.");
```

(a)

Equivalent

```
if (even)
  System.out.println(
    "It is even.");
```

(b)



## Problem: An Improved Math Learning Tool

This example creates a program to teach a first grade child how to learn subtractions. The program randomly generates two single-digit integers number1 and number2 with number1 >= number2 and displays a question such as “What is 9 – 2?” to the student. After the student types the answer, the program displays whether the answer is correct.

SubtractionQuiz Run



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```
import java.util.Scanner;
 public class SubtractionQuiz {
      public static void main(String[] args) {
          // 1. Generate two random single-digit integers
        int number1 = (int)(Math.random() * 10);
        int number2 = (int)(Math.random() * 10);
          // 2. If number1 < number2, swap number1 with number2
        if (number1 < number2)
          { int temp = number1;
           number1 = number2;
           number2 = temp;
          }
    // 3. Prompt the student to answer "what is number1 – number2?“
 System.out.print ("What is " + number1 + " - " + number2 + "? ");
 Scanner input = new Scanner(System.in);
int answer = input.nextInt();
     // 4. Grade the answer and display the result
 if (number1 - number2 == answer)
      System.out.println("You are correct!");
 else { System.out.println("Your answer is wrong.");
        System.out.println(number1 + " - " + number2 + " should be " + (number1 - number2));
       }
    }
}
```



## Problem: Body Mass Index

Body Mass Index (BMI) is a measure of health on weight. It can be calculated by taking your weight in kilograms and dividing by the square of your height in meters. The interpretation of BMI for people 16 years or older is as follows:

| BMI | Interpretation |
|---|---|
| BMI < 18.5 | Underweight |
| 18.5 <= BMI < 25.0 | Normal |
| 25.0 <= BMI < 30.0 | Overweight |
| 30.0 <= BMI | Obese |

ComputeAndInterpretBMI Run



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# Problem: Computing Taxes

The US federal personal income tax is calculated based on the filing status and taxable income. There are four filing statuses: single filers, married filing jointly, married filing separately, and head of household. The tax rates for 2009 are shown below.

| *Marginal Tax Rate* | *Single* | *Married Filing Jointly or Qualifying Widow(er)* | *Married Filing Separately* | *Head of Household* |
|---|---|---|---|---|
| **10%** | $0 – $8,350 | $0 – $16,700 | $0 – $8,350 | $0 – $11,950 |
| **15%** | $8,351 – $33,950 | $16,701 – $67,900 | $8,351 – $33,950 | $11,951 – $45,500 |
| **25%** | $33,951 – $82,250 | $67,901 – $137,050 | $33,951 – $68,525 | $45,501 – $117,450 |
| **28%** | $82,251 – $171,550 | $137,051 – $208,850 | $68,526 – $104,425 | $117,451 – $190,200 |
| **33%** | $171,551 – $372,950 | $208,851 – $372,950 | $104,426 – $186,475 | $190,201 – $372,950 |
| **35%** | $372,951+ | $372,951+ | $186,476+ | $372,951+ |




# Problem: Computing Taxes, cont.

```
if (status == 0) {
  // Compute tax for single filers
}
else if (status == 1) {
  // Compute tax for married file jointly
  // or qualifying widow(er)
}
else if (status == 2) {
  // Compute tax for married file separately
}
else if (status == 3) {
  // Compute tax for head of household
}
else {
  // Display wrong status
}
```

ComputeTax Run




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# Logical Operators

| Operator | Name | Description |
|---|---|---|
| ! | not | logical negation |
| && | and | logical conjunction |
| \|\| | or | logical disjunction |
| ^ | exclusive or | logical exclusion |




# Truth Table for Operator !

| p | !p | Example (assume age = 24, weight = 140) |
|---|---|---|
| true | false | !(age > 18) is false, because (age > 18) is true. |
| false | true | !(weight == 150) is true, because (weight == 150) is false. |




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# Truth Table for Operator &&

| $p_1$ | $p_2$ | $p_1$ && $p_2$ | Example (assume age = 24, weight = 140) |
|---|---|---|---|
| **false** | false | false | (age <= 18) && (weight < 140) is false, because both conditions are both false. |
| **false** | true | false | |
| **true** | false | false | (age > 18) && (weight > 140) is false, because (weight > 140) is false. |
| **true** | true | true | (age > 18) && (weight >= 140) is true, because both (age > 18) and (weight >= 140) are true. |




# Truth Table for Operator | |

| $p_1$ | $p_2$ | $p_1$ \|\| $p_2$ | Example (assume age = 24, weihgt = 140) |
|---|---|---|---|
| **false** | false | false | |
| **false** | true | true | (age > 34) \|\| (weight <= 140) is true, because (age > 34) is false, but (weight <= 140) is true. |
| **true** | false | true | (age > 14) \|\| (weight >= 150) is false, because (age > 14) is true. |
| **true** | true | true | |




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# Truth Table for Operator ^

| $p_1$ | $p_2$ | $p_1$ ^ $p_2$ | Example (assume age = 24, weight = 140) |
|---|---|---|---|
| **false** | false | false | (age > 34) ^ (weight > 140) is true, because (age > 34) is false and (weight > 140) is false. |
| **false** | true | true | (age > 34) ^ (weight >= 140) is true, because (age > 34) is false but (weight >= 140) is true. |
| **true** | false | true | (age > 14) ^ (weight > 140) is true, because (age > 14) is true and (weight > 140) is false. |
| **true** | true | false | |




# Examples

Here is a program that checks whether a number is divisible by 2 and 3, whether a number is divisible by 2 or 3, and whether a number is divisible by 2 or 3 but not both:

TestBooleanOperators Run




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# Examples

```
System.out.println("Is " + number + " divisible by 2 and 3? " +
  ((number % 2 == 0) && (number % 3 == 0)));

System.out.println("Is " + number + " divisible by 2 or 3? " +
  ((number % 2 == 0) || (number % 3 == 0)));

System.out.println("Is " + number +
  " divisible by 2 or 3, but not both? " +
  ((number % 2 == 0) ^ (number % 3 == 0)));
```

TestBooleanOperators

Run



# The & and | Operators

Supplement III.B, "The & and | Operators"



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## The & and | Operators

```
If x is 1, what is x after this
 expression?
(x > 1) & (x++ < 10)

If x is 1, what is x after this
 expression?
(1 > x) && ( 1 > x++)

How about (1 == x) | (10 > x++)?
(1 == x) || (10 > x++)?
```




## Problem: Determining Leap Year?

This program first prompts the user to enter a year as an int value and checks if it is a leap year.

A year is a leap year if it is divisible by 4 but not by 100, or it is divisible by 400.

(year % 4 == 0 && year % 100 != 0) || (year % 400 == 0)

LeapYear Run




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## Problem: Lottery

Write a program that randomly generates a lottery of a two-digit number, prompts the user to enter a two-digit number, and determines whether the user wins according to the following rule:

- If the user input matches the lottery in exact order, the award is $10,000.
- If the user input matches the lottery, the award is $3,000.
- If one digit in the user input matches a digit in the lottery, the award is $1,000.

Lottery Run



## `switch` Statements

```
switch (status) {
  case 0:  compute taxes for single filers;
           break;
  case 1:  compute taxes for married file jointly;
           break;
  case 2:  compute taxes for married file separately;
           break;
  case 3:  compute taxes for head of household;
           break;
  default: System.out.println("Errors: invalid status");
           System.exit(1);
}
```



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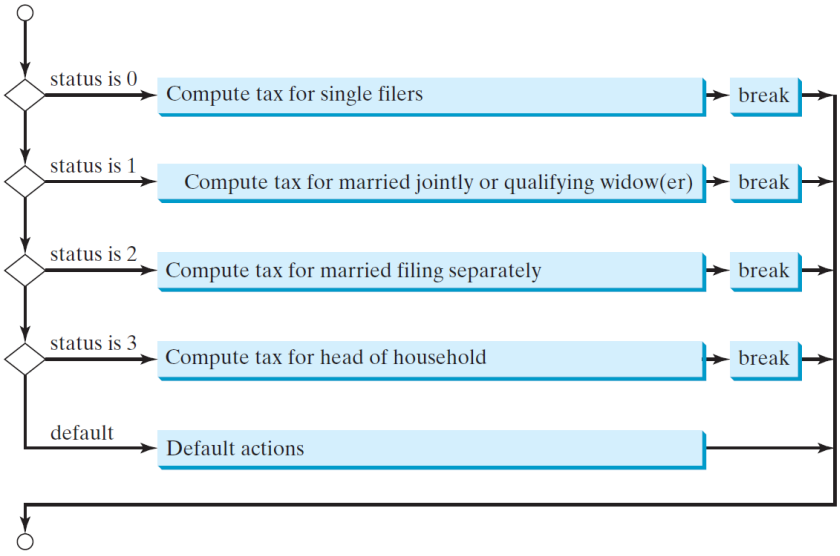
# switch Statement Flow Chart






# switch Statement Rules

The switch-expression must yield a value of char, byte, short, or int type and must always be enclosed in parentheses.

The value1, ..., and valueN must have the same data type as the value of the switch-expression. The resulting statements in the case statement are executed when the value in the case statement matches the value of the switch-expression. Note that value1, ..., and valueN are constant expressions, meaning that they cannot contain variables in the expression, such as **1 + x**.

```
switch (switch-expression) {
  case value1:  statement(s)1;
          break;
  case value2: statement(s)2;
          break;
  …
  case valueN: statement(s)N;
          break;
  default: statement(s)-for-default;
}
```



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# switch Statement Rules

The keyword break is optional, but it should be used at the end of each case in order to terminate the remainder of the switch statement. If the break statement is not present, the next case statement will be executed.

```
switch (switch-expression) {
  case value1:  statement(s)1;
                break;
  case value2: statement(s)2;
                break;
  …
  case valueN: statement(s)N;
                break;
  default: statement(s)-for-default;
}
```

The default case, which is optional, can be used to perform actions when none of the specified cases matches the switch-expression.

When the value in a **case** statement matches the value of the **switch-expression**, the statements *starting from this case* are executed until either a **break** statement or the end of the **switch** statement is reached.



animation

# Trace switch statement

Suppose day is 2:

```
switch (day) {
  case 1:
  case 2:
  case 3:
  case 4:
  case 5: System.out.println("Weekday"); break;
  case 0:
  case 6: System.out.println("Weekend");
}
```



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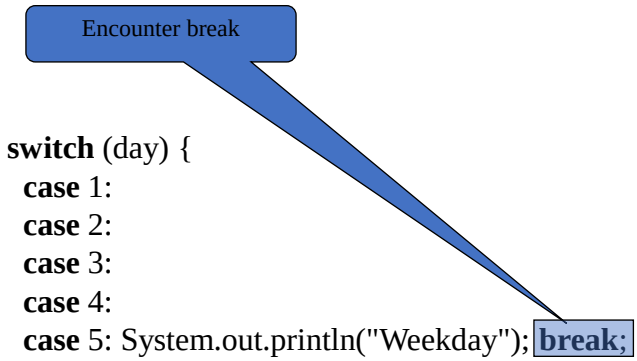
animation

## Trace switch statement






## Conditional Operators

```
if (x > 0)
  y = 1
else
  y = -1;
```

is equivalent to

```
y = (x > 0) ? 1 : -1;
```

(boolean-expression) ? expression1 : expression2

Ternary operator
Binary operator
Unary operator



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# Conditional Operator

```
if (num % 2 == 0)
  System.out.println(num + "is even");
else
  System.out.println(num + "is odd");
```

```
System.out.println(
  (num % 2 == 0)? num + "is even" :
  num + "is odd");
```



# Operator Precedence

```
var++, var--
+, - (Unary plus and minus), ++var,--var
(type) Casting
! (Not)
*, /, % (Multiplication, division, and remainder)
+, - (Binary addition and subtraction)
<, <=, >, >= (Relational operators)
==, !=; (Equality)
^ (Exclusive OR)
&& (Conditional AND) Short-circuit AND
|| (Conditional OR) Short-circuit OR
=, +=, -=, *=, /=, %= (Assignment operator)
```



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## Operator Precedence and Associativity

The expression in the parentheses is evaluated first. (Parentheses can be nested, in which case the expression in the inner parentheses is executed first.) When evaluating an expression without parentheses, the operators are applied according to the precedence rule and the associativity rule.

If operators with the same precedence are next to each other, their associativity determines the order of evaluation. All binary operators except assignment operators are left-associative.




## Operator Associativity

When two operators with the same precedence are evaluated, the *associativity* of the operators determines the order of evaluation. All binary operators except assignment operators are *left-associative*.

a – b + c – d is equivalent to ((a – b) + c) – d

Assignment operators are *right-associative*. Therefore, the expression

a = b += c = 5 is equivalent to a = (b += (c = 5))




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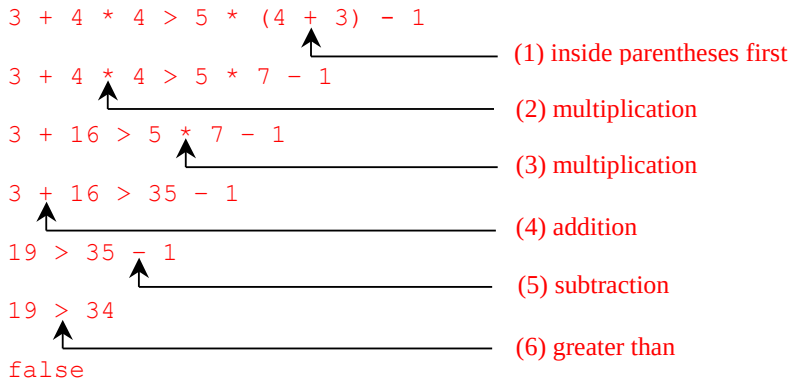
# Example

Applying the operator precedence and associativity rule, the expression 3 + 4 * 4 > 5 * (4 + 3) - 1 is evaluated as follows:






# Debugger

Debugger is a program that facilitates debugging. You can use a debugger to

- Execute a single statement at a time.
- Trace into or stepping over a method.
- Set breakpoints.
- Display variables.
- Display call stack.
- Modify variables



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