02: Elementary Programming

Programming Technique I

(SCSJ1013)

What a Is a Program Made Of?

- Common elements in programming languages:
  - Key Words
  - Programmer-Defined Identifiers
  - Operators
  - Punctuation
  - Syntax

Key Words

- Also known as reserved words
- Have a special meaning in C++
- Can not be used for another purpose
- Written using lowercase letters
- Examples in program (shown in green):

```
using namespace std;
int main()
```

Example Program

```
#include <iostream>
using namespace std;

int main()
{
   double num1 = 5,
          num2, sum;
    num2 = 12;

    sum = num1 + num2;
    cout << "The sum is " << sum;
    return 0;
}
```

Operators

- Used to perform operations on data
- Many types of operators
  - Arithmetic: `+, -, *, /`
  - Assignment: `=`
- Examples in program (shown in green):

```
num2 = 12;
sum = num1 + num2;
```

Example Program

```
#include <iostream>
using namespace std;

int main()
{
    double num1 = 5, num2, sum;
    num2 = 12;

    sum = num1 + num2;
    cout << "The sum is " << sum;
    return 0;
}
```

Punctuation

- Characters that mark the end of a statement, or that separate items in a list
- Example in program (shown in green):

```
double num1 = 5,
       num2, sum;
num2 = 12;
```

Example Program

```
#include <iostream>
using namespace std;

int main()
{
   double num1 = 5,
          num2, sum;
    num2 = 12;

    sum = num1 + num2;
    cout << "The sum is " << sum;
    return 0;
}
```

The `#include` Directive

- Inserts the contents of another file into the program
- Is a preprocessor directive
  - Not part of the C++ language
  - Not seen by compiler
- Example:

```
#include <iostream>
```

Comments

- Are used to document parts of a program
- Are written for persons reading the source code of the program
  - Indicate the purpose of the program
  - Describe the use of variables
  - Explain complex sections of code
- Are ignored by the compiler

Single-Line Comments

- Begin with **//** through to the end of line

```
int length = 12; // length in inches
int width = 15;  // width in inches
int area;        // calculated area

// Calculate rectangle area
area = length * width;
```

Multi-Line Comments

- Begin with `/*` and end with `*/`
- Can span multiple lines

```
/*-----------------------------
   Here's a multi-line comment
  -----------------------------*/
```

- Can also be used as single-line comments

```
int area;    /* Calculated area */
```

The Parts of a C++ Program

Statement	Purpose
`// sample C++ program`	comment
`#include <iostream>`	preprocessor directive
`using namespace std;`	which namespace to use
`int main()`	beginning of function named `main`
`{`	beginning of block for `main`
`   cout << "Hello, there!";`	output statement
`   return 0;`	send 0 back to the operating system
`}`	end of block for `main`

Special Characters

Character	Name	Description
//	Double Slash	Begins a comment
#	Pound Sign	Begins preprocessor directive
< >	Open, Close Brackets	Encloses filename used in `#include` directive
( )	Open, Close Parentheses	Used when naming function
{ }	Open, Close Braces	Encloses a group of statements
" "	Open, Close Quote Marks	Encloses string of characters
;	Semicolon	Ends a programming statement

Important Details

- C++ is case-sensitive. Uppercase and lowercase characters are different characters. '`Main`' is not the same as '`main`'.
- Every `{` must have a corresponding `}`, and vice-versa.

Variables

Variables

- A variable is a named location in computer memory (in RAM)
- It holds a piece of data
- It must be *defined* before it can be used
- Example variable definition:

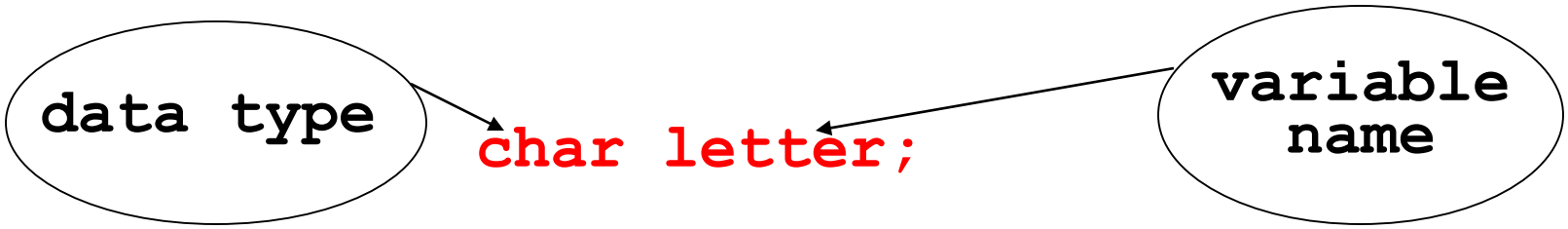
```
double num1;
```

Example Program

```
#include <iostream>
using namespace std;

int main()
{
    double num1 = 5,
           num2, sum;
    num2 = 12;

    sum = num1 + num2;
    cout << "The sum is " << sum;
    return 0;
}
```

Variables, Constants, and the Assignment Statement

- Variable
  - Has a name and a type of data it can hold



  - Is used to reference a location in memory where a value can be stored
  - Must be defined before it can be used
  - The value that is stored can be changed, *i.e.*, it can "vary"

Variables

- If a new value is stored in the variable, it replaces the previous value
- The previous value is overwritten and can no longer be retrieved

```
int age;
age = 17;        // age is 17
cout << age;     // Displays 17
age = 18;        // Now age is 18
cout << age;     // Displays 18
```

Variables: Example

Program 2-7

```
1  // This program has a variable.
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7     int number;
8
9     number = 5;
10    cout << "The value in number is " << number << endl;
11    return 0;
12 }
```

Variable Definition

Program Output

```
The value in number is 5
```

Identifiers

Identifiers

- Programmer-chosen names to represent parts of the program, such as variables
- Name should indicate the use of the identifier
- Cannot use C++ key words as identifiers
- Must begin with alphabetic character or _, followed by alphabetic, numeric, or _ . Alpha may be uppercase or lowercase
- Example in program (shown in green):

```
double num1
```

Example Program

```
#include <iostream>
using namespace std;

int main()
{
    double num1 = 5,
           num2, sum;
    num2 = 12;

    sum = num1 + num2;
    cout << "The sum is " << sum;
    return 0;
}
```

Valid and Invalid Identifiers

IDENTIFIER	VALID?	REASON IF INVALID
`totalSales`		
`total_Sales`		
`total.Sales`		
`4thQtrSales`		
`totalSale$`		

Lines vs. Statements

In a source file,

A line is all of the characters entered before a carriage return.

Blank lines improve the readability of a program.

Here are four sample lines. Line 3 is blank:

```
double num1 = 5, num2, sum;
num2 = 12;

sum = num1 + num2;
```

Lines vs. Statements

In a source file,

A statement is an instruction to the computer to perform an action.

A statement may contain keywords, operators, programmer-defined identifiers, and punctuation.

A statement may fit on one line, or it may occupy multiple lines.

Here is a single statement that uses two lines:

```
double num1 = 5,
       num2, sum;
```

Literals

- Literal: a value that is written into a program's code.
  - "hello, there" (string literal)
  - 12 (integer literal)

Literals: Example

Program 2-9

```
1  // This program has literals and a variable.
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7     int apples;
8
9     apples = 20;
10    cout << "Today we sold " << apples << " bushels of apples.\n";
11    return 0;
12 }
```

Program Output

```
Today we sold 20 bushels of apples.
```

Literals: Example

Program 2-9

```
1  // This program has literals and a variable.
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7     int apples;
8
9     apples = 20;
10    cout << "Today we sold " << apples << " bushels of apples.\n";
11    return 0;
12 }
```

This is a string literal

Program Output

```
Today we sold 20 bushels of apples.
```

In-Class Exercise

Examine the following program. List all the variables and literals that appear in the program.

```
#include <iostream>
using namespace std;

int main()
{    int little;
     int big;

     little = 2;
     big = 2000;
     cout<<"The little number is " <<little<<endl;
     cout<<"The big number is "<<big<<endl;
     return 0;
}
```

In-Class Exercise

What will the following program display on the screen?

```
#include <iostream>
using namespace std;

int main()
{
    int num;
    num = 712;
    cout<< "The value is " << num << endl;
    return 0;
}
```

Input and Output

Input using `cin`

The `cin` Object

- Standard input object
- Like **`cout`**, requires **`iostream`** file
- Used to read input from keyboard
- Information retrieved from **`cin`** with **`>>`**
- Input is stored in one or more variables

Program 3-1

```
1  // This program asks the user to enter the length and width of
2  // a rectangle. It calculates the rectangle's area and displays
3  // the value on the screen.
4  #include <iostream>
5  using namespace std;
6
7  int main()
8  {
9     int length, width, area;
10
11    cout << "This program calculates the area of a ";
12    cout << "rectangle.\n";
13    cout << "What is the length of the rectangle? ";
14    cin >> length;
15    cout << "What is the width of the rectangle? ";
16    cin >> width;
17    area = length * width;
18    cout << "The area of the rectangle is " << area << ".\n";
19    return 0;
20 }
```

Program Output with Example Input Shown in Bold

```
This program calculates the area of a rectangle.
What is the length of the rectangle? 10 [Enter]
What is the width of the rectangle? 20 [Enter]
The area of the rectangle is 200.
```

The `cin` Object

- **`cin`** converts data to the type that matches the variable:

```
int height;
cout << "How tall is the room? ";
cin >> height;
```

The `cin` Object

- Can be used to input more than one value:

```
cin >> height >> width;
```

- Multiple values from keyboard must be separated by spaces

- Order is important: first value entered goes to first variable, etc.

Displaying a Prompt

- A prompt is a message that instructs the user to enter data.
- You should always use **`cout`** to display a prompt before each cin statement.

```
cout << "How high is the room? ";
cin >> height;
```

Program 3-2

```
1  // This program asks the user to enter the length and width of
2  // a rectangle. It calculates the rectangle's area and displays
3  // the value on the screen.
4  #include <iostream>
5  using namespace std;
6
7  int main()
8  {
9     int length, width, area;
10
11    cout << "This program calculates the area of a ";
12    cout << "rectangle.\n";
13    cout << "Enter the length and width of the rectangle ";
14    cout << "separated by a space.\n";
15    cin >> length >> width;
16    area = length * width;
17    cout << "The area of the rectangle is " << area << endl;
18    return 0;
19 }
```

Program Output with Example Input Shown in Bold

```
This program calculates the area of a rectangle.
Enter the length and width of the rectangle separated by a space.
10 20 [Enter]
The area of the rectangle is 200
```

Reading Strings with `cin`

- Can be used to read in a string
- Must first declare an array to hold characters in string:

```
char myName[21];
```

- `myName` is a name of an array, `21` is the number of characters that can be stored (the size of the array), including the NULL character at the end
- Can be used with `cin` to assign a value:

```
cin >> myName;
```

Program 3-4

```
1  // This program demonstrates how cin can read a string into
2  // a character array.
3  #include <iostream>
4  using namespace std;
5
6  int main()
7  {
8     char name[21];
9
10    cout << "What is your name? ";
11    cin >> name;
12    cout << "Good morning " << name << endl;
13    return 0;
14 }
```

Program Output with Example Input Shown in Bold

```
What is your name? Charlie [Enter]
Good morning Charlie
```

In-Class Exercise

- Solve the problem. Add array of characters to the output.

Sample of output:

Enter an integer: 7

Enter a decimal number : 2.25

Enter a single character : R

Enter an array of characters: Programming

Output using `cout`

The `cout` Object

- Displays information on computer screen
- Use **<<** to send information to cout

```
cout << "Hello, there!";
```

- Can use **<<** to send multiple items to cout

```
cout << "Hello, " << "there!";
```

Or

```
cout << "Hello, ";
cout << "there!";
```

Starting a New Line

- To get multiple lines of output on screen
  - Use **`endl`**

```
cout << "Hello, there!" << endl;
```

  - Use **`\n`** in an output string

```
cout << "Hello, there!\n";
```

Notice that the \n is INSIDE the string.

In-Class Exercise

- Rearrange the following program statements in the correct order.

```
int main()
}
return 0;
#include <iostream>
cout<<"In 1492 Columbus sailed the ocean
  blue.";
{
using namespace std;
```

- What is the output of the program when it is properly arranged?

Data type and constant

Number Systems

- Numbers can be represented in a variety of ways.
- The representation depends on what is called the BASE.
- You write these numbers as:
  - **Number** $_{\textbf{base}}$

Number Systems

- The following are the four most common representations.
- Decimal (base 10)
  - Commonly used
  - Valid digits are from 0 to 9
  - Example: 12610 (normally written as just 126)
- Binary (base 2)
  - Valid digits are 0 and 1
  - Example: 11111102

- The following are the four most common representations.
- Octal (base 8)
  - Valid digits are from 0 to 7
  - Example: 1768
- Hexadecimal (base 16)
  - Valid digits are from 0 to 9 and A to F (or from a to f)
  - Example: 7E16

Integer Data Types

- Designed to hold whole numbers
- Can be **`signed`** or **`unsigned`**

  `12 -6 +3`

- Available in different sizes (*i.e.*, number of bytes): **`short`**, **`int`**, and **`long`**
- Size of **`short`** ≤ size of **`int`** ≤ size of **`long`**

Integral Constants

- To store an integer constant in a long memory location, put '**L**' at the end of the number: `1234L`
- Constants that begin with '**0**' (zero) are octal, or base 8: `075`
- Constants that begin with '**0x**' are hexadecimal, or base 16: `0x75A`

Defining Variables

- Variables of the same type can be defined
  - In separate statements

```
int length;
int width;
```

  - In the same statement

```
int length,
    width;
```

- Variables of different types must be defined in separate statements

Floating-Point Data Types

- Designed to hold real numbers

  `12.45` `-3.8`

- Stored in a form similar to scientific notation
- Numbers are all signed
- 3 data types to represent floating-point numbers: **`float`**, **`double`**, and **`long double`**
- Size of **`float`** ≤ size of **`double`** ≤ size of **`long double`**

Floating-point Constants

- Can be represented in
  - Fixed point (decimal) notation:

    `31.4159` `0.0000625`
  - E notation:

    `3.14159E1` `6.25e-5`
- Are **`double`** by default
- Can be forced to be float `3.14159F` or long double `0.0000625L`

Assigning Floating-point Values to Integer Variables

If a floating-point value is assigned to an integer variable

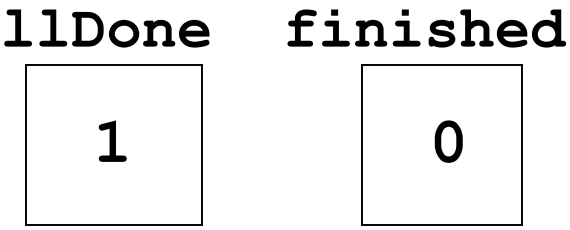
- The fractional part will be truncated (*i.e.*, "chopped off" and discarded)
- The value is not rounded

```
int rainfall = 3.88;
cout << rainfall;  // Displays 3
```

The `bool` Data Type

- Represents values that are **`true`** or **`false`**
- **`bool`** values are stored as short integers
- **`false`** is represented by 0, **`true`** by 1

```
bool allDone = true;
bool finished = false;
```



The `char` Data Type

- Used to hold single characters or very small integer values
- Usually occupies 1 byte of memory
- A numeric code representing the character is stored in memory

SOURCE CODE **MEMORY**

```
char letter = 'C';
```

letter

67

The `char` Data Type

- Used to hold single characters or very small integer values
- Usually occupies 1 byte of memory
- A numeric code representing the character is stored in memory

SOURCE CODE **MEMORY**

```
char letter = 'C';
```

letter

67

In-Class Exercise

- What is wrong with the following program?

```
#include <iostream>
using namespace std;

int main()
{     char letter;

     letter = "Z";
     cout<<letter<<endl;
     return 0;
}
```

Summary of data types

Name	Description	Size	Range
char	Character or small integer.	1byte	signed: -128 to 127 unsigned: 0 to 255
short int (short)	Short Integer.	2bytes	signed: -32768 to 32767 unsigned: 0 to 65535
int	Integer.	4bytes	signed: -2147483648 to 2147483647 unsigned: 0 to 4294967295
long int (long)	Long integer.	4bytes	signed: -2147483648 to 2147483647 unsigned: 0 to 4294967295
bool	Boolean value. It can take one of two values: true or false.	1byte	true or false
float	Floating point number.	4bytes	+/- 3.4e +/- 38 (~7 digits)
double	Double precision floating point number.	8bytes	+/- 1.7e +/- 308 (~15 d
long double	Long double precision floating point number.	8bytes	+/- 1.7e +/- 308 (~15 digits)

Naming Constant

Named Constants

- Named constant (constant variable): variable whose content cannot be changed during program execution
- Used for representing constant values with descriptive names:

```
const double TAX_RATE = 0.0675;
const int NUM_STATES = 50;
```

- Often named in uppercase letters

Defining constants

- You can define your own names for constants that you use very often without having to resort to memory-consuming variables, simply by using the `#define` preprocessor directive.
- Its format:

```
#define identifier value
```

- Example:

```
#include <iostream>
using namespace std;
#define PI 3.14159
#define NEWLINE '\n'
int main ()
{ double r=5.0;
  double circle;
  circle = 2 * PI * r;
  cout << circle;
  cout << NEWLINE;  return 0;}
```

Declared constants (const)

- With the const prefix you can declare constants with a specific type in the same way as you would do with a variable
- Example:

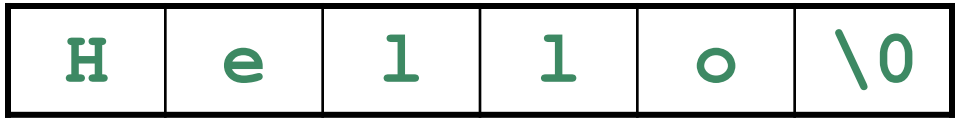
```
#include <iostream>
using namespace std;
int main ()
{ double r=5.0,circle;
  const double PI = 3.14159;
  const char NEWLINE = '\n';
  circle = 2 * PI * r;
  cout << circle;
  cout << NEWLINE; return 0;}
```

String Constant

- Can be stored a series of characters in consecutive memory locations

  `"Hello"`

- Stored with the null terminator, `\0`, at end



- Is comprised of characters between the " "

A character or a string constant?

- A character constant is a single character, enclosed in single quotes:

```
'C'
```

- A string constant is a sequence of characters enclosed in double quotes:

```
"Hello, there!"
```

- A single character in double quotes is a string constant, not a character constant:

```
"C"
```

The C++ **string** Class

- Must **#include <string>** to create and use string objects
- Can define **string** variables in programs

```
string name;
```

- Can assign values to string variables with the assignment operator

```
name = "George";
```

- Can display them with **cout**

```
cout << name;
```

Determining the Size of a Data Type

The **`sizeof`** operator gives the size of any data type or variable

```
double amount;
cout << "A float is stored in "
     << sizeof(float) << " bytes\n";
cout << "Variable amount is stored in
 "
     << sizeof(amount) << " bytes\n";
```

More on Variable Assignments and Initialization

- Assigning a value to a variable
  - Assigns a value to a previously created variable
  - A single variable name must appear on left side of the = symbol

```
int size;
size = 5;      // legal
5 = size;      // not legal
```

Variable Assignment vs. Initialization

- Initializing a variable
  - Gives an initial value to a variable at the time it is created
  - Can initialize some or all variables of definition

```
int length = 12;
int width = 7, height = 5, area;
```

Scope

- The scope of a variable is that part of the program where the variable may be used
- A variable cannot be used before it is defined

```
int a;
cin >> a;    // legal
cin >> b;    // illegal
int b;
```

In-Class Exercise

- Trace the following program. Can it be compiled?

```
#include <iostream>
using namespace std;

int main()
{
    cout<<value;

    int value;
    return 0;
}
```

Arithmetic Expression

Arithmetic Operators and Expression

Arithmetic Operators

- Used for performing numeric calculations
- C++ has unary, binary, and ternary operators
  - unary (1 operand) `-5`
  - binary (2 operands) `13 - 7`
  - ternary (3 operands) `exp1 ? exp2 : exp3`

Binary Arithmetic Operators

SYMBOL	OPERATION	EXAMPLE	ans
+	addition	`ans = 7 + 3;`	10
-	subtraction	`ans = 7 - 3;`	4
*	multiplication	`ans = 7 * 3;`	21
/	division	`ans = 7 / 3;`	2
%	modulus	`ans = 7 % 3;`	1

/ Operator

- C++ division operator (/) performs integer division if both operands are integers

```
cout << 13 / 5;     // displays 2
cout <<  2 / 4;     // displays 0
```

- If either operand is floating-point, the result is floating-point

```
cout << 13 / 5.0;   // displays 2.6
cout << 2.0 / 4;    // displays 0.5
```

% Operator

- C++ modulus operator (%) computes the remainder resulting from integer division

```
cout << 9 % 2;   // displays 1
```

- % requires integers for both operands

```
cout << 9 % 2.0; // error
```

In-Class Exercise

- Identify as many syntax errors as you can in the following program

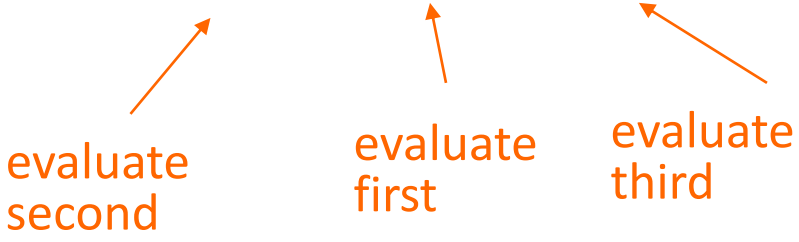
```
*/ what is wrong with this program?/*
#include iostream
using namespace std;

int main();
}
    int a, b, c
    a=3
    b=4
    c=a+b
    Cout<"The value of c is "<C;
    return 0;
{
```

Order of Operations

In an expression with more than one operator, evaluation is in this order:

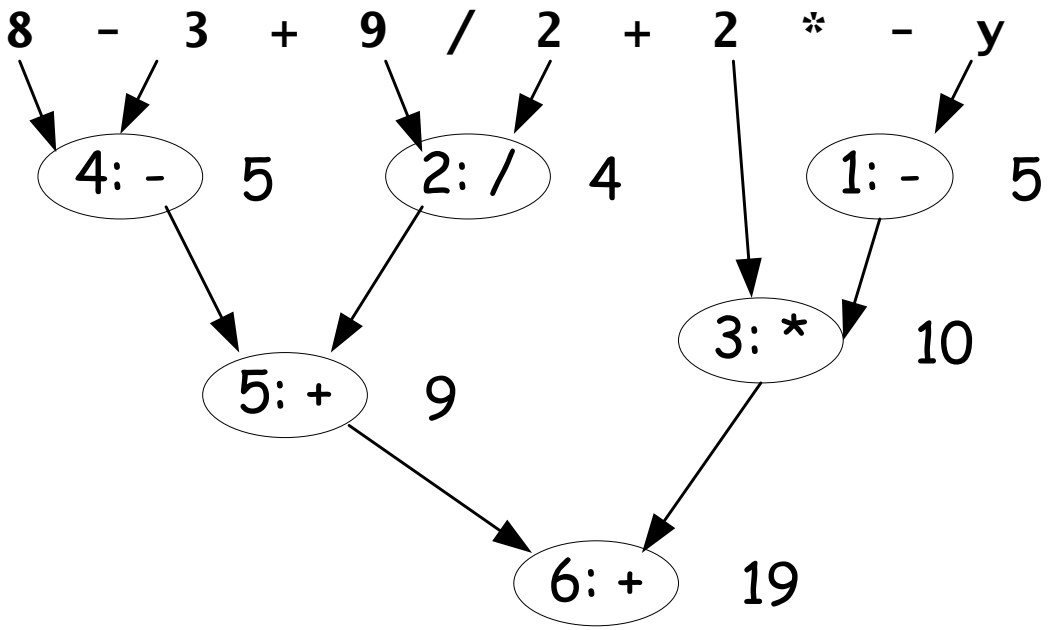
- ()
- – (unary negation), in order, right to left
- * / %, in order, left to right
- + –, in order, left to right

In the expression `2 + 2 * 2 - 2`



Example

```
int z, y=-5;
z= 8 - 3 + 9 / 2 + 2 * - y;
z= 8 - (3 + 9 / 2) + 2 * - y;// try this
```



Order of Operations

Show prove for the following expression

Table 3-2 Some Expressions

Expression	Value
`5 + 2 * 4`	13
`10 / 2 - 3`	2
`8 + 12 * 2 - 4`	28
`4 + 17 % 2 - 1`	4
`6 - 3 * 2 + 7 - 1`	6

Associativity of Operators

- – (unary negation) associates right to left
- `*, /, %, +, –` associate left to right
- parentheses ( ) can be used to override the order of operations:

```
 2 + 2   *   2 – 2   = 4
(2 + 2)  *   2 – 2   = 6
 2 + 2   *  (2 – 2)  = 2
(2 + 2)  *  (2 – 2)  = 0
```

Grouping with Parentheses

Table 3-4 More Expressions

Expression	Value
`(5 + 2) * 4`	28
`10 / (5 - 3)`	5
`8 + 12 * (6 - 2)`	56
`(4 + 17) % 2 - 1`	0
`(6 - 3) * (2 + 7) / 3`	9

Type Conversion

When You Mix Apples and Oranges: *Type Conversion*

- Operations are performed between operands of the same type.
- If not of the same type, C++ will convert one to be the type of the other
- This can impact the results of calculations.

Type Conversion

- Type Conversion: automatic conversion of an operand to another data type
- Promotion: convert to a higher type
- Demotion: convert to a lower type

Hierarchy of Types

Highest:

```
long double
double
float
unsigned long
long
unsigned int
int
```

Lowest:

Ranked by largest number they can hold

Conversion Rules

1) `char`, `short`, `unsigned short` automatically promoted to `int`
   - For arithmetic operation

```
char c='A'; cout<<6+c; // int
```

2) When operating on values of different data types, the lower one is promoted to the type of the higher one.

```
int i=25; cout<<6.1+i; // float
```

3) When using the = operator, the type of expression on right will be converted to type of variable on left

```
int x, y =25; float z=2.5;
x=y+z; //int
```

Algebraic Expressions

- Multiplication requires an operator:

  $Area = lw$ is written as `Area = l * w;`

- There is no exponentiation operator:

  $Area = s^2$ is written as `Area = pow(s, 2);`

- Parentheses may be needed to maintain order of operations:

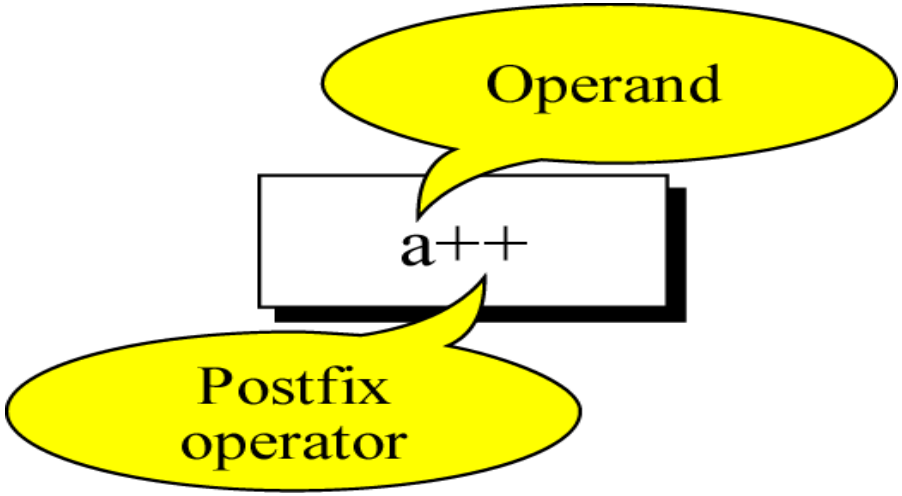
$$m = \frac{y_2 - y_1}{x_2 - x_1}$$ is written as `m = (y2-y1) /(x2-x1);`

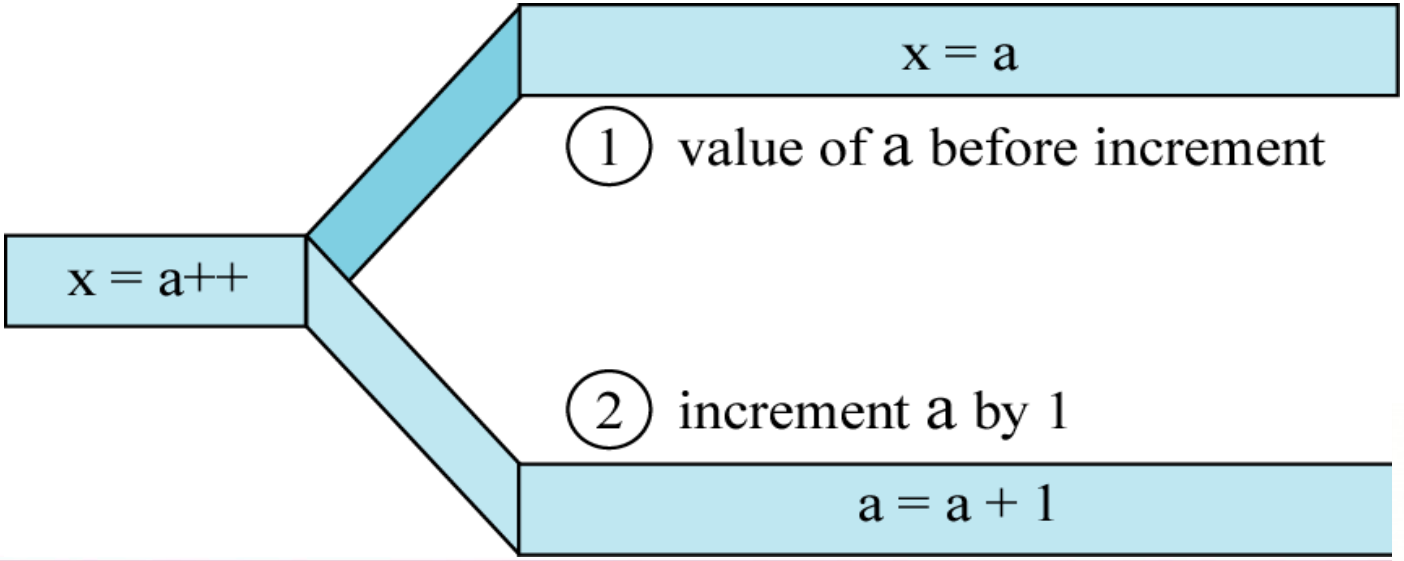
Algebraic Expressions

Table 3-5 Algebraic and C++ Multiplication Expressions

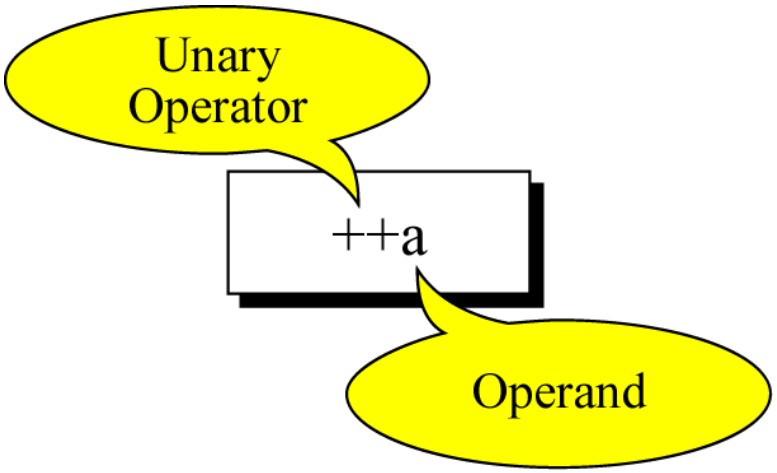
Algebraic Expression	Operation	C++ Equivalent
$6B$	`6 times B`	`6 * B`
$(3)(12)$	`3 times 12`	`3 * 12`
$4xy$	`4 times x times y`	`4 * x * y`

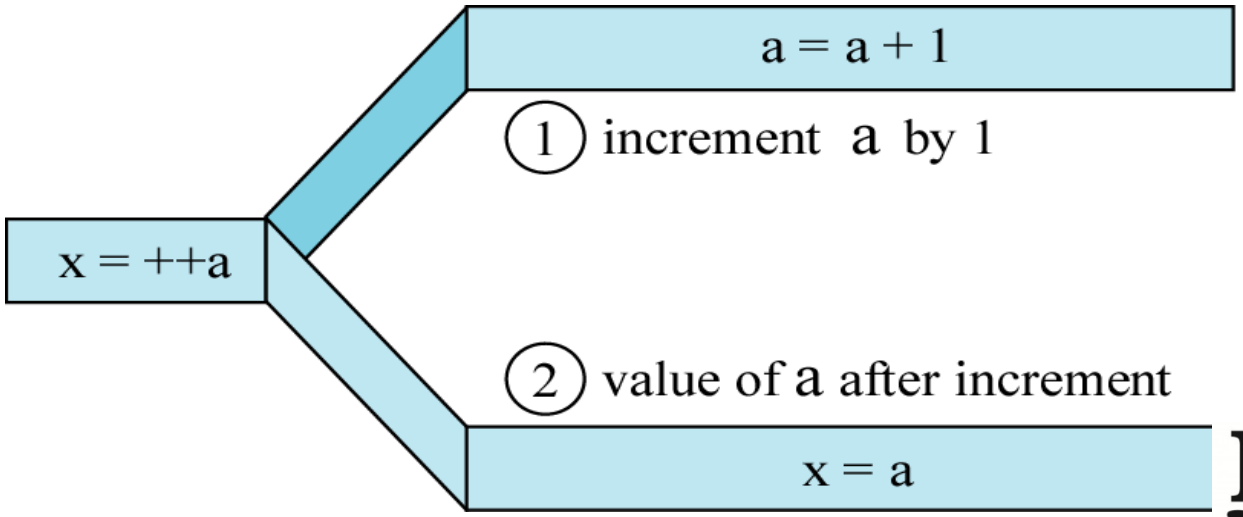
Postfix expression





Prefix expression





In-Class Exercise

- What would be the value of nilai_kedua:

```
int kira = 5;
int nilai_pertama = 10, nilai_kedua;

nilai_kedua= 5* kira-- + nilai_pertama;
nilai_kedua = 5* --kira +nilai+pertama;
```

Overflow and Underflow

Overflow and Underflow

- Occurs when assigning a value that is too large (overflow) or too small (underflow) to be held in a variable
- Variable contains value that is ‘wrapped around’ set of possible values
- Different systems may display a warning/error message, stop the program, or continue execution using the incorrect value

Type Casting

Type Casting

- Used for manual data type conversion
- Useful for floating point division using int:

```
double m;
m = static_cast<double>(y2-y1)
                        /(x2-x1);
```

- Useful to see `int` value of a `char` variable:

```
char ch = 'C';
cout << ch << " is "
     << static_cast<int>(ch);
```

Example

Program 3-10

```
1  // This program uses a type cast to avoid integer division.
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7     int books;          // Number of books to read
8     int months;         // Number of months spent reading
9     double perMonth;    // Average number of books per month
10
11    cout << "How many books do you plan to read? ";
12    cin >> books;
13    cout << "How many months will it take you to read them? ";
14    cin >> months;
15    perMonth = static_cast<double>(books) / months;
16    cout << "That is " << perMonth << " books per month.\n";
17    return 0;
18 }
```

Program Output with Example Input Shown in Bold

```
How many books do you plan to read? 30 [Enter]
How many months will it take you to read them? 7 [Enter]
That is 4.28571 books per month.
```

C-Style and Prestandard Type Cast Expressions

- C-Style cast: data type name in `()`

```
cout << ch << " is " << (int)ch;
```

- Prestandard C++ cast: value in `()`

```
cout << ch << " is " << int(ch);
```

- Both are still supported in C++, although `static_cast` is preferred

Multiple Assignment and Combined Assignment

Multiple Assignment and Combined Assignment

- The = can be used to assign a value to multiple variables:

```
x = y = z = 5;
```

- Value of = is the value that is assigned
- Associates right to left:

```
x = (y = (z = 5));
```

value is 5

value is 5

value is 5

Combined Assignment

- Look at the following statement:

```
sum = sum + 1;
```

This adds 1 to the variable **`sum`**.

Combined Assignment

- The combined assignment operators provide a shorthand for these types of statements.
- The statement

```
sum = sum + 1;
```

is equivalent to

```
sum += 1;
```

Combined Assignment Operators

Operator	Example	Equivalent to
+=	i+=3 i += j +3	i = i+3 i = i + (j+3)
-=	i-=3 i -= j +3	i = i-3 i = i - (j+3)
*=	i*=3 i *= j +3	i = i*3 i = i * (j+3)
/=	i/=3 i /= j +3	i = i/3 i = i / (j+3)
%=	i%=3 i %= j +3	i = i%3 i = i % (j+3)

In-Class Exercise

Assume that int a = 1 and double d = 1.0, and that each expression is independent. What are the results of the following expressions?

i) a = 46/9;

ii) a = 46 % 9 + 4 * 4 – 2;

iii) a = 45 + 43 % 5 * (23 * 3 % 2);

iv) a %=3 / a + 3;

v) d += 1.5 * 3 + (++a);

vi) d -= 1.5 * 3 + a++;