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>
```

No ; goes here

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:

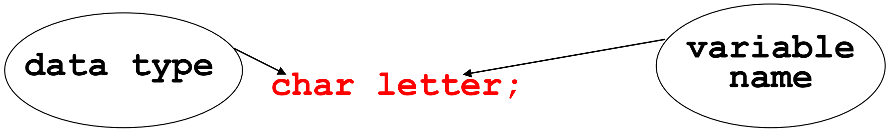
```
double num1;
```

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



```
char letter;
```

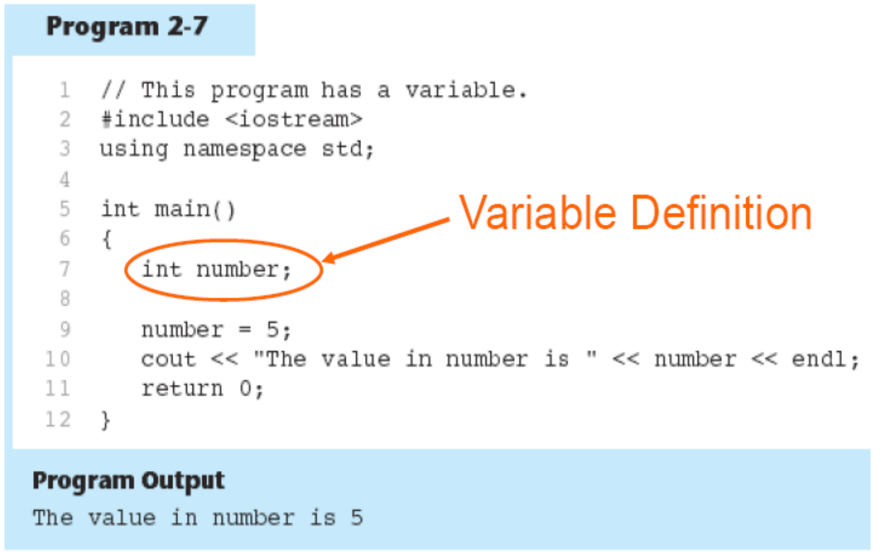
  - Is used to reference a location in memory where a value can be stored
  - Must be defined before it can be used
  - The value that is stored can be changed, *i.e.*, it can "vary"

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

```
// This program has a variable.
#include <iostream>
using namespace std;

int main()
{
   int number;

   number = 5;
   cout << "The value in number is " << number << endl;
   return 0;
}
```

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.

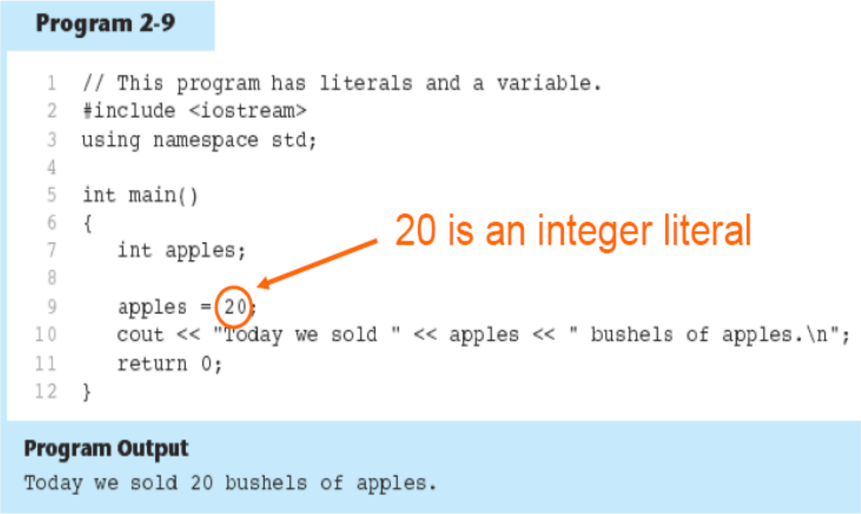
Here is a single statement that uses two lines:

```
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

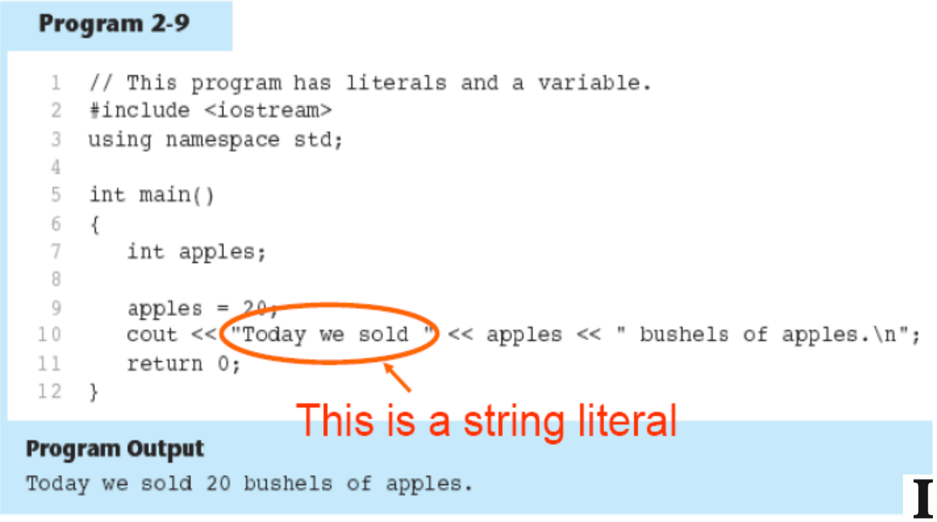
```
// This program has literals and a variable.
#include <iostream>
using namespace std;

int main()
{
   int apples;

   apples = 20;
   cout << "Today we sold " << apples << " bushels of apples.\n";
   return 0;
}
```

20 is an integer literal

Program Output

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

Literals: Example



Program 2-9

```
// This program has literals and a variable.
#include <iostream>
using namespace std;

int main()
{
   int apples;

   apples = 20;
   cout << "Today we sold " << apples << " bushels of apples.\n";
   return 0;
}
```

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?

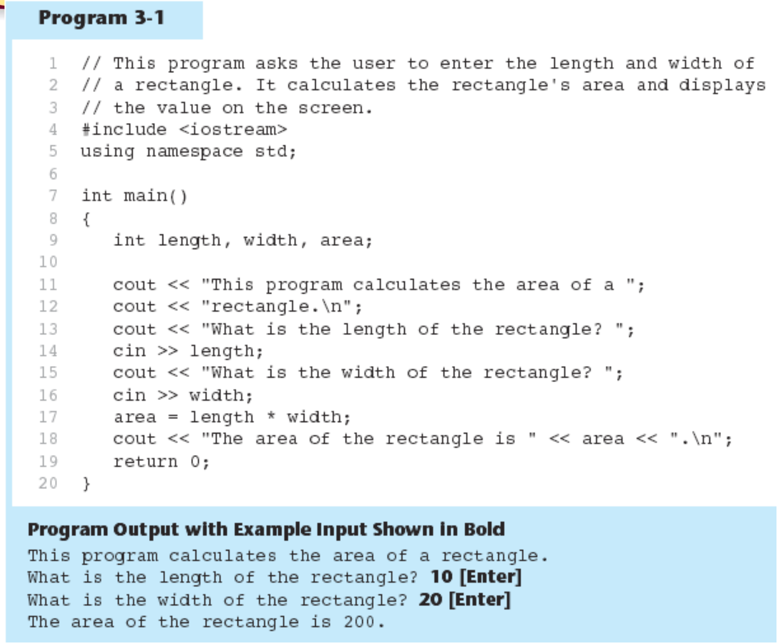
```
#include <iostream>
using namespace std;

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

```
// This program asks the user to enter the length and width of
// a rectangle. It calculates the rectangle's area and displays
// the value on the screen.
#include <iostream>
using namespace std;

int main()
{
   int length, width, area;

   cout << "This program calculates the area of a ";
   cout << "rectangle.\n";
   cout << "What is the length of the rectangle? ";
   cin >> length;
   cout << "What is the width of the rectangle? ";
   cin >> width;
   area = length * width;
   cout << "The area of the rectangle is " << area << ".\n";
   return 0;
}
```

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:

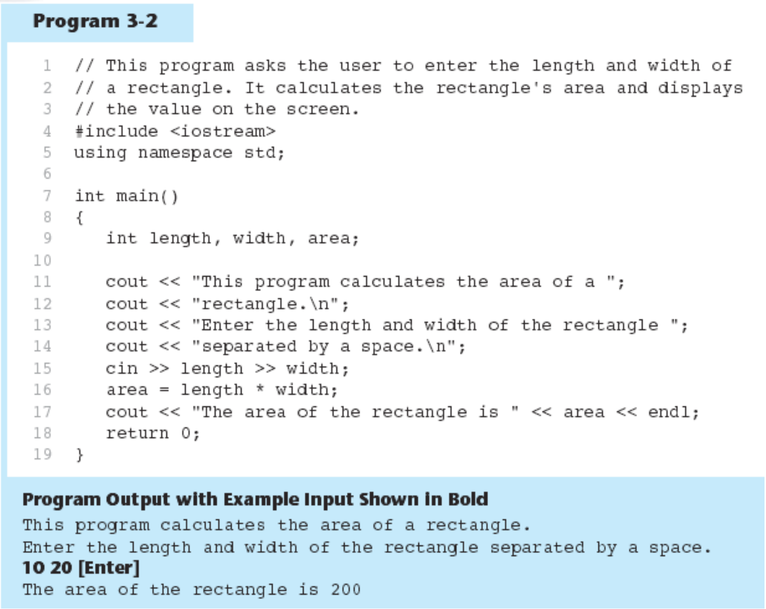
```
cin >> height >> width;
```

- 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

```
// This program asks the user to enter the length and width of
// a rectangle. It calculates the rectangle's area and displays
// the value on the screen.
#include <iostream>
using namespace std;

int main()
{
   int length, width, area;

   cout << "This program calculates the area of a ";
   cout << "rectangle.\n";
   cout << "Enter the length and width of the rectangle ";
   cout << "separated by a space.\n";
   cin >> length >> width;
   area = length * width;
   cout << "The area of the rectangle is " << area << endl;
   return 0;
}
```

Program Output with Example Input Shown in Bold

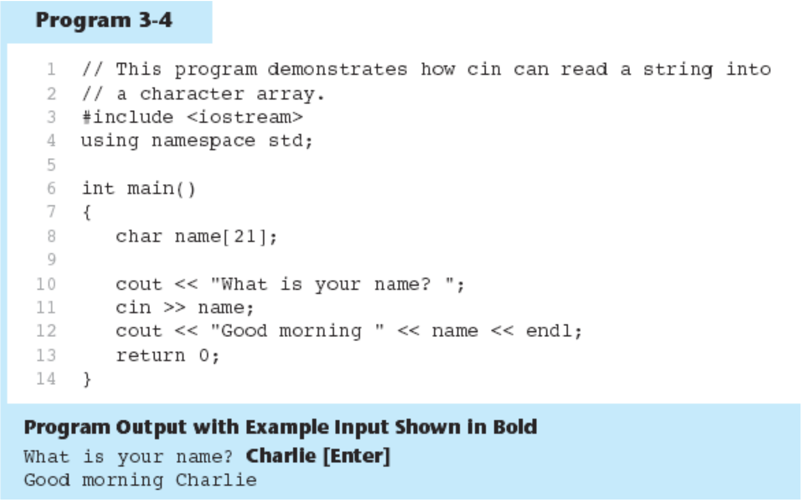
```
This program calculates the area of a rectangle.
Enter the length and width of the rectangle separated by a space.
10 20 [Enter]
The area of the rectangle is 200
```

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

```
// This program demonstrates how cin can read a string into
// a character array.
#include <iostream>
using namespace std;

int main()
{
   char name[21];

   cout << "What is your name? ";
   cin >> name;
   cout << "Good morning " << name << endl;
   return 0;
}
```

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 0.000625L

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;
```

allDone	finished
1	0

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

H	e	l	l	o	\0

- 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:

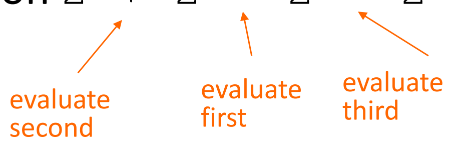
()

– (unary negation), in order, right to left

`*` `/` `%`, in order, left to right

`+` `–`, in order, left to right

In the expression `2 + 2 * 2 – 2`



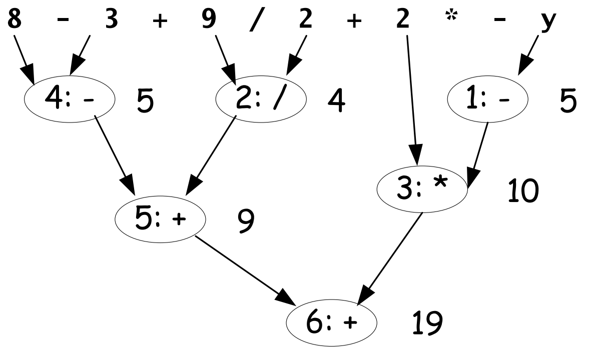
evaluate second

evaluate first

evaluate third

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

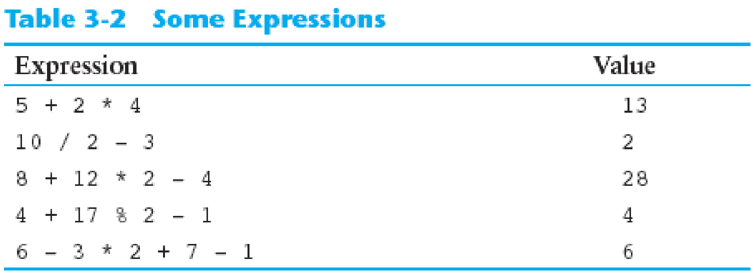


Table 3-2 Some Expressions

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

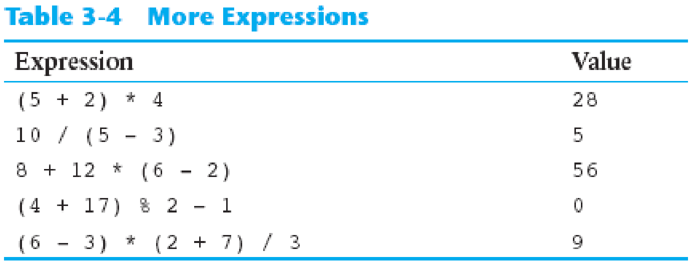


Table 3-4 More Expressions

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

- <u>Type Conversion</u>: automatic conversion of an operand to another data type
- <u>Promotion</u>: convert to a higher type
- <u>Demotion</u>: 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

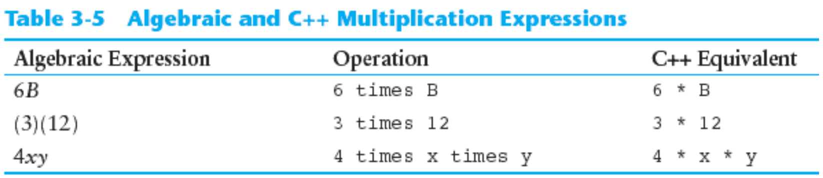
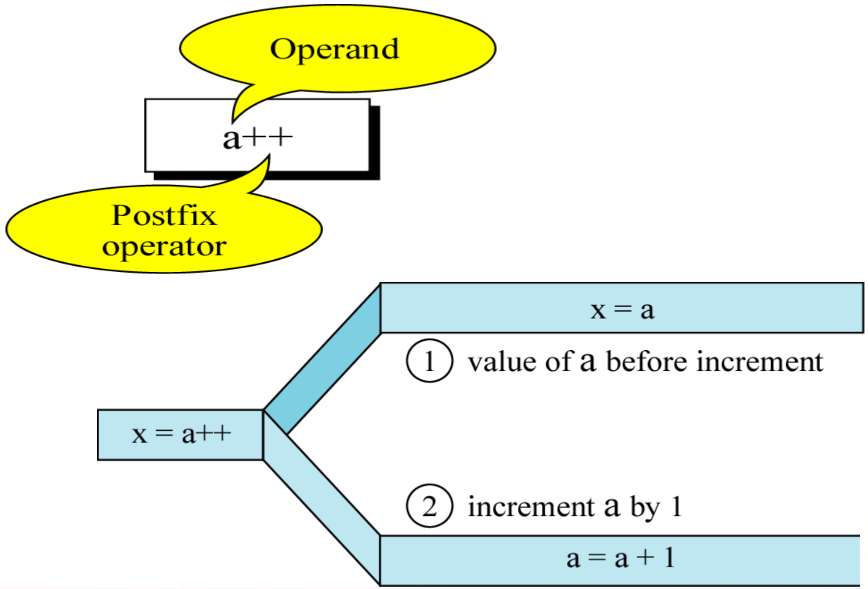


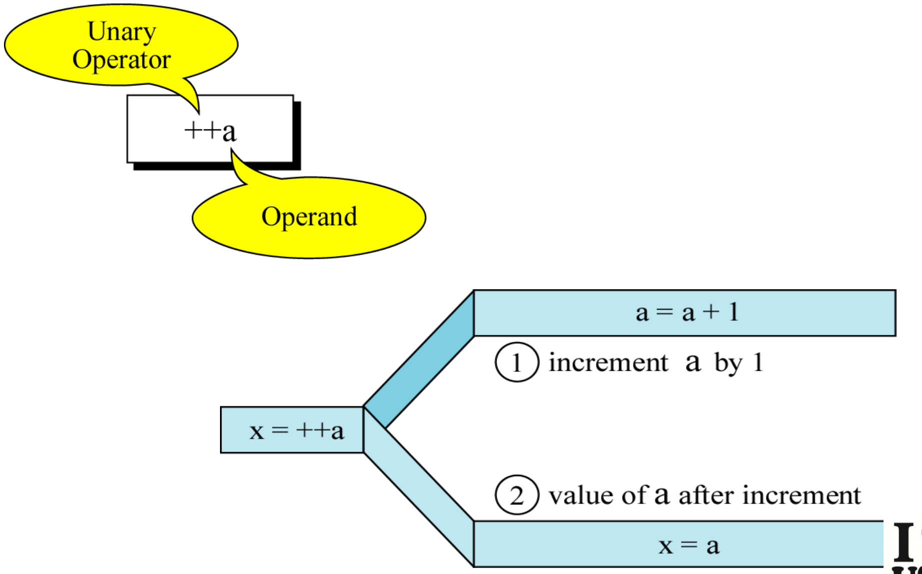
Table 3-5 Algebraic and C++ Multiplication Expressions

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

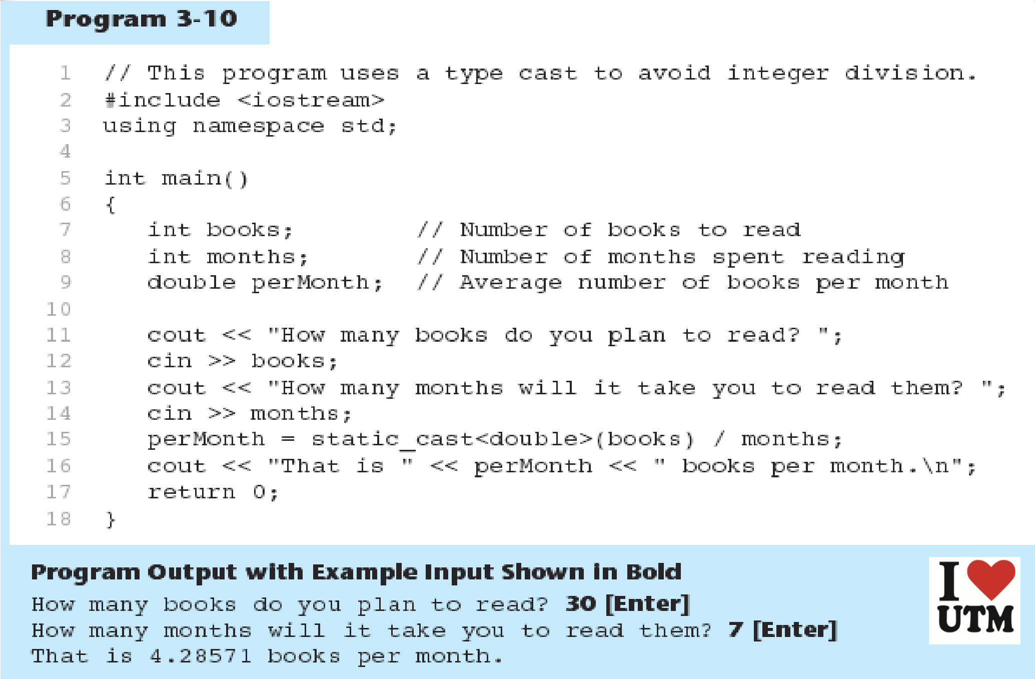
- Used for manual data type conversion
- Useful for floating point division using int:

```
 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

```
// This program uses a type cast to avoid integer division.
#include <iostream>
using namespace std;

int main()
{
   int books;         // Number of books to read
   int months;        // Number of months spent reading
   double perMonth;   // Average number of books per month

   cout << "How many books do you plan to read? ";
   cin >> books;
   cout << "How many months will it take you to read them? ";
   cin >> months;
   perMonth = static_cast<double>(books) / months;
   cout << "That is " << perMonth << " books per month.\n";
   return 0;
}
```

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

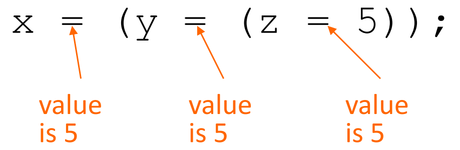
Multiple Assignment and Combined Assignment

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++;