Programming Techniques I
SCJ1013
Arithmetic Expression

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The `cin` Object

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;
```

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 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.

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
```

Exercise Week5_1

- Refer to Exercise 3 No. 1 in pg. 79.

- 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

Mathematical Expressions

Mathematical Expressions

- Can create complex expressions using multiple mathematical operators
- An expression can be a literal, a variable, or a mathematical combination of constants and variables
- Can be used in assignment, `cout`, other statements:

```
area = 2 * PI * radius;
  cout << "border is: " << 2*(l+w);
```

Order of Operations

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

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

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

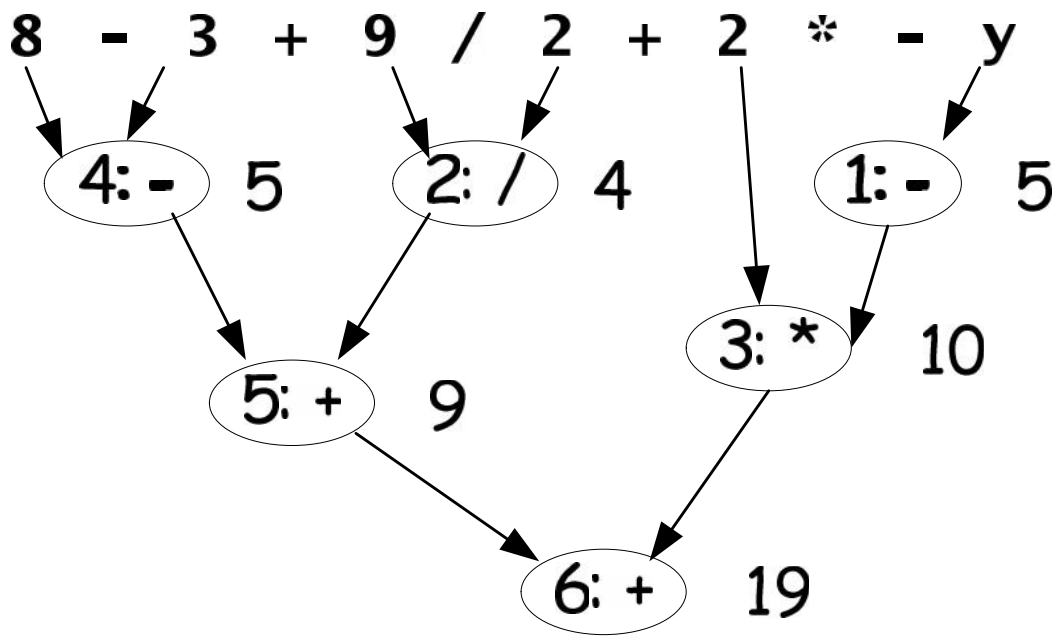
evaluate second

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

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

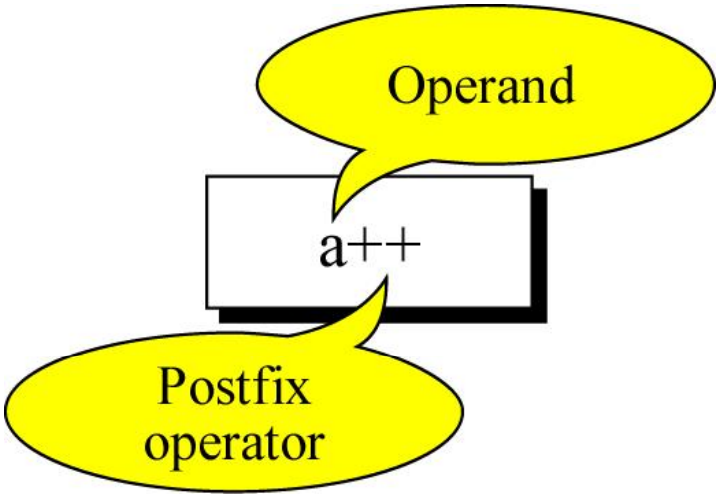
```
m = (y2-y1) / (x2-x1);
```

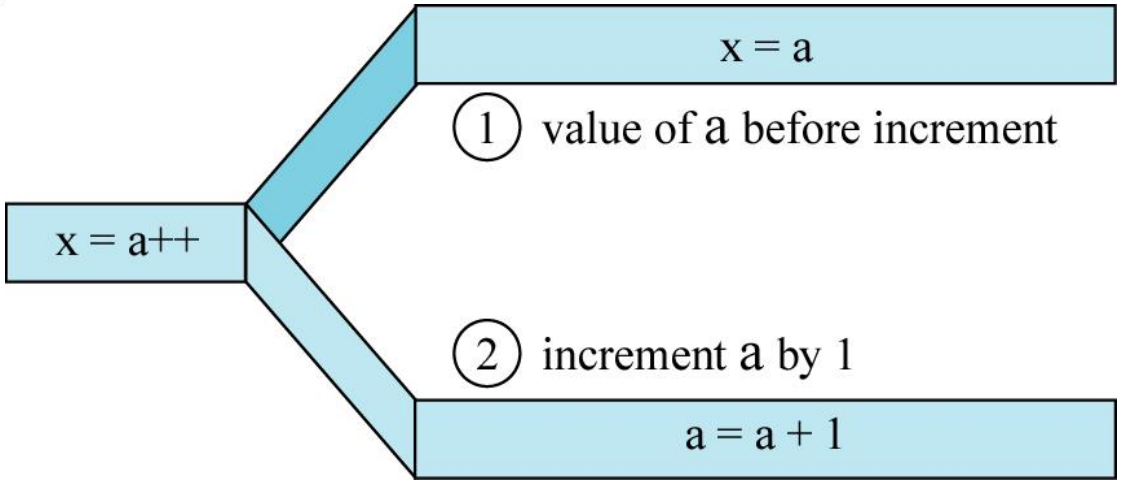
Algebraic Expressions

Table 3-5 Algebraic and C++ Multiplication Expressions

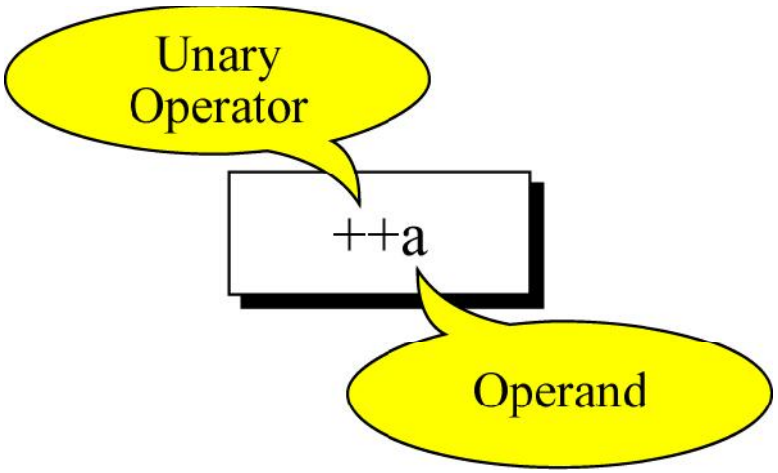
Algebraic Expression	Operation	C++ Equivalent
$6B$	`6 times B`	`6 * B`
$(3)(12)$	`3 times 12`	`3 * 12`
$4xy$	`4 times x times y`	`4 * x * y`

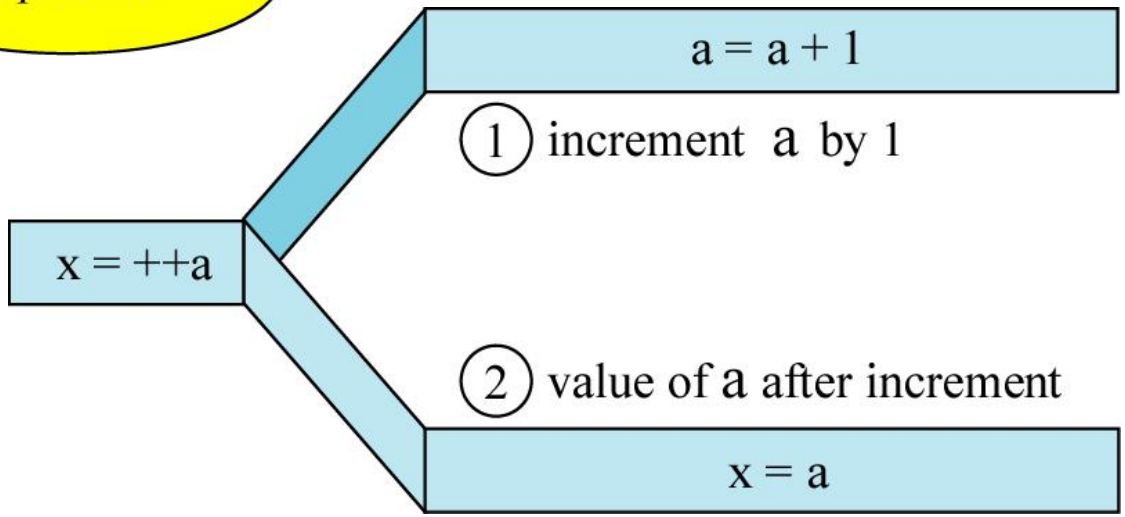
Postfix expression





Prefix expression





Exercise Week5_2 [Lab5, Exe1, No7, pg60]

- Write the formula in C++ statement.

$$b^2 - 4ac$$

$$\frac{a+b}{c+d}$$

$$\frac{1}{1+x^2}$$

When You Mix Apples and Oranges: *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.

Hierarchy of Types

Highest:

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

Lowest:

Ranked by largest number they can hold

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

Conversion Rules

1) `char`, `short`, `unsigned short` automatically promoted to `int`
   - Forarithmetic 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
```

Exercise Week5_3 [Lab5, Exe1, No8, pg61]

- Given the following program, apply the Coercion rules & identify the output

```
int main(){
 char upperb='B';
 int j=2, k=3;
 double r=24.5, s=3.0, t;

 cout<<"Rule 1 = "<<r+j;
 cout<<"Rule 2 = "<<upperb+j; //'B'=66
 t=r+j;
 cout<<"Rule 3 = "<<t;

 return 0;
}
```

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

Overflow and Underflow

```
#include <iostream>
using namespace std;
int main()
{
short testVar = 32767;          //short max
cout << testVar << endl;
testVar = testVar + 1;
cout << testVar << endl;
testVar = testVar - 1;
cout << testVar << endl;
return 0;
}
```

Program Output

32767
-32768
32767

Type Casting

Type Casting

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

```
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);
```

Type Casting - 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

Exercise Week5_4

- Correct the error of the program using type casting

```
int main(){
char upperb='B';
int j=2, k=3;
double r=24.5, s=3.0, t;

t=r- static_cast<int>(s*3)%(2+j)/k;

cout<<"t= "<<t;
return 0;
}
```

Named Constants

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

Named Constants - example

Program 3-12

```
// This program calculates the area of a circle.
// The formula for the area of a circle is PI times
// the radius squared. PI is 3.14159.
#include <iostream>
#include <cmath>   // needed for pow function
using namespace std;

int main()
{
   const double PI = 3.14159;
   double area, radius;

   cout << "This program calculates the area of a circle.\n";
   cout << "What is the radius of the circle? ";
   cin >> radius;
   area = PI * pow(radius, 2.0);
   cout << "The area is " << area << endl;
   return 0;
}
```

Constants and Array Sizes

- It is a common practice to use a named constant to indicate the size of an array:

```
const int SIZE = 21;
char name[SIZE];
```

`const` vs. `#define`

- `#define` – C-style of naming constants:

```
#define NUM_STATES 50
```

  – Note no ; at end
- Interpreted by pre-processor rather than compiler
- Does not occupy memory location like `const`

Exercise Week5_5

- Refer to Lab 6 Exe. 3 No. 3 in pg. 80.

- Solve the problems using constant values to represent the conversion factors.

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`**.

Other Similar Statements

Table 3-8 (Assume x = 6)

Statement	What It Does	Value of x After the Statement
`x = x + 4;`	Adds 4 to x	10
`x = x - 3;`	Subtracts 3 from x	3
`x = x * 10;`	Multiplies x by 10	60
`x = x / 2;`	Divides x by 2	3
`x = x % 4`	Makes x the remainder of x / 4	2

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

Table 3-9

Operator	Example Usage	Equivalent to
+=	x += 5;	x = x + 5;
-=	y -= 2;	y = y - 2;
*=	z *= 10;	z = z * 10;
/=	a /= b;	a = a / b;
%=	c %= 3;	c = c % 3;

Try:

d -= 5 * 3 + a++;

Thank You

Q & A