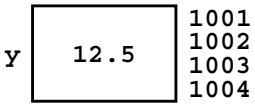
Modifying objects

Operators and Expressions

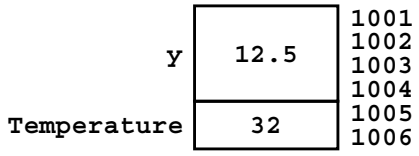
Memory Depiction

```
float y = 12.5;
```



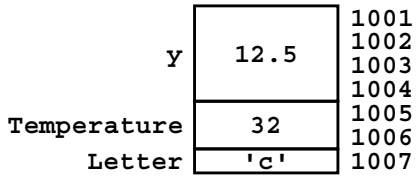
Memory Depiction

```
float y = 12.5;
int Temperature = 32;
```



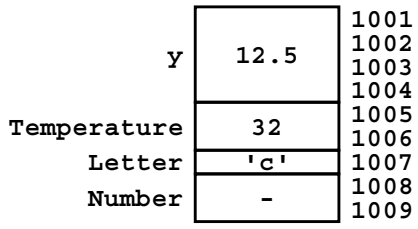
Memory Depiction

```
float y = 12.5;
int Temperature = 32;
char Letter = 'c';
```



Memory Depiction

```
float y = 12.5;
int Temperature = 32;
char Letter = 'c';
int Number;
```



Assignment Statement

Target becomes source

- Basic form
  - *object* = *expression* ;

```
Celsius = (Fahrenheit - 32) * 5 / 9;
y = m * x + b;
```

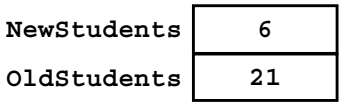
- Action
  - Expression is evaluated
  - Expression value stored in object

Definition

```
int NewStudents = 6;
```

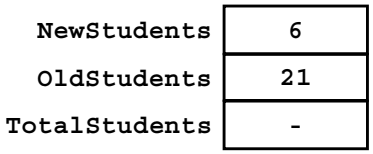
Definition

```
int NewStudents = 6;
int OldStudents = 21;
```



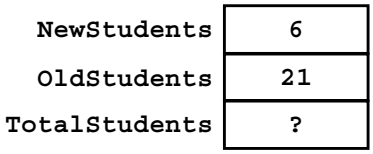
Definition

```
int NewStudents = 6;
int OldStudents = 21;
int TotalStudents;
```



Assignment Statement

```
int NewStudents = 6;
int OldStudents = 21;
int TotalStudents;
```




```
TotalStudents = NewStudents + OldStudents;
```

Assignment Statement

```
int NewStudents = 6;
int OldStudents = 21;
int TotalStudents;

TotalStudents = NewStudents + OldStudents;
```

NewStudents	6
OldStudents	21
TotalStudents	27

Assignment Statement

```
int NewStudents = 6;
int OldStudents = 21;
int TotalStudents;

TotalStudents = NewStudents + OldStudents;

OldStudents = TotalStudents;
```

NewStudents	6
OldStudents	?
TotalStudents	27

Assignment Statement

```
int NewStudents = 6;
int OldStudents = 21;
int TotalStudents;

TotalStudents = NewStudents + OldStudents;

OldStudents = TotalStudents;
```

NewStudents	6
OldStudents	27
TotalStudents	27

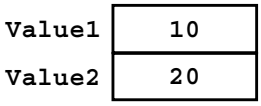
Consider

```
int Value1 = 10;
```

Value1	10

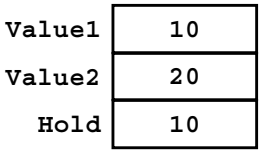
Consider

```
int Value1 = 10;
int Value2 = 20;
```



Consider

```
int Value1 = 10;
int Value2 = 20;
int Hold = Value1;
```



Consider

```
int Value1 = 10;
int Value2 = 20;
int Hold = Value1;

Value1 = Value2;
```

Value1	?
Value2	20
Hold	10

Consider

```
int Value1 = 10;
int Value2 = 20;
int Hold = Value1;

Value1 = Value2;
```

Value1	20
Value2	20
Hold	10

Consider

```
int Value1 = 10;
int Value2 = 20;
int Hold = Value1;

Value1 = Value2;

Value2 = Hold;
```

Value1	20
Value2	?
Hold	10

Consider

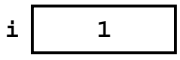
```
int Value1 = 10;
int Value2 = 20;
int Hold = Value1;

Value1 = Value2;

Value2 = Hold;
```

Value1	20
Value2	10
Hold	10

- We *swapped* the values of objects Value1 and Value2 using Hold as temporary holder for Value1's starting value!

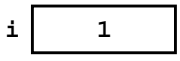
Incrementing

```
int i = 1;
```

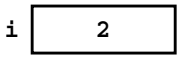


Incrementing

```
int i = 1;
```




```
i = i + 1;
```



Assign the value of expression `i + 1` to `i`

Evaluates to 2

Const Definitions

- Modifier **`const`** indicates that an object cannot be changed
  - Object is read-only
- Useful when defining objects representing physical and mathematical constants

```
const float Pi = 3.1415;
```

- Value has a name that can be used throughout the program

```
const int SampleSize = 100;
```

- Makes changing the constant easy
  - Only need to change the definition and recompile

Assignment Conversions

- Floating-point expression assigned to an integer object is truncated
- Integer expression assigned to a floating-point object is converted to a floating-point value
- Consider

```
float y = 2.7;
int i = 15;
int j = 10;
i = y;                  // i is now 2
cout << i << endl;
y = j;                  // y is now 10.0
cout << y << endl;
```

Nonfundamental Types

- Nonfundamental as they are additions to the language
- C++ permits definition of new types and *classes*
  - A class is a special kind of type
- Class objects typically have
  - *Data members* that represent attributes and values
  - *Member functions* for object inspection and manipulation
  - Members are accessed using the selection operator (.)

    ```
    j = s.size();
    ```
  - *Auxiliary* functions for other behaviors
- Libraries often provide special-purpose types and classes
- Programmers can also define their own types and classes

Examples

- Standard Template Library (STL) provides class **`string`**
- EzWindows library provides several graphical types and classes
  - **`SimpleWindow`** is a class for creating and manipulating window objects
  - **`RectangleShape`** is a class for creating and manipulating rectangle objects

Class string

- Class string
  - Used to represent a sequence of characters as a single object
- Some definitions

```
string Name = "Joanne";
string DecimalPoint = ".";
string empty = "";
string copy = name;
string Question = '?';       // illegal
```

Nonfundamental Types

- To access a library use a preprocessor directive to add its definitions to your program file

```
#include <string>
```

- The using statement makes syntax less clumsy
  - Without it

```
std::string s = "Sharp";
std::string t = "Spiffy";
```

  - With it

```
using namespace std; // std contains string
string s = "Sharp";
string t = "Spiffy";
```

EzWindows Library Objects

- Definitions are the same form as other objects
- Example

```
SimpleWindow W;
```

  - Most non-fundamental classes have been created so that an object is automatically initialized to a sensible value

- `SimpleWindow` objects have member functions to process messages to manipulate the objects
  - Most important member function is `Open()` which causes the object to be displayed on the screen
    - Example

```
W.Open();
```

Initialization

- Class objects may have several attributes to initialize
- Syntax for initializing an object with multiple attributes

  `Type Identifier(`Exp_1`, `Exp_2`, ..., `Exp_n`);`

- SimpleWindow object has several optional attributes

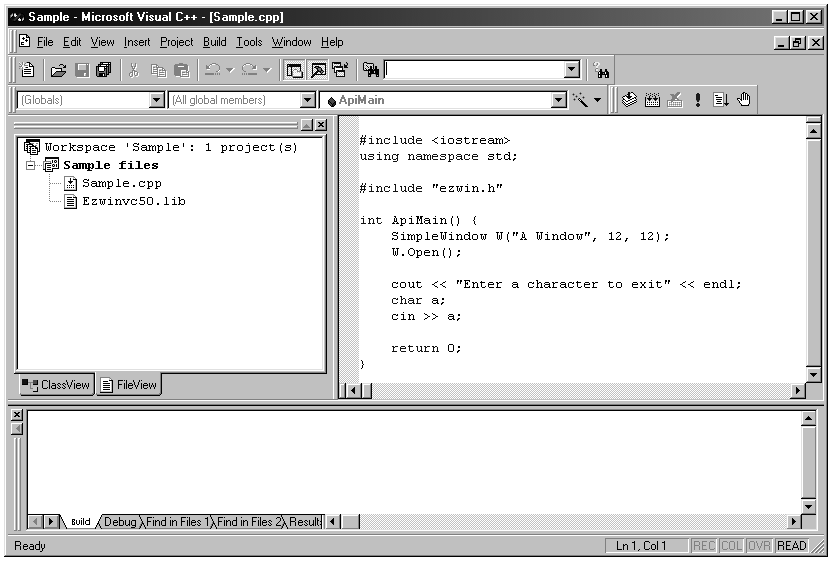
```
SimpleWindow W("Window Fun", 8, 4);
```

  - First attribute
    - Window banner
  - Second attribute
    - Width of window in centimeters
  - Third attribute
    - Height of window in centimeters

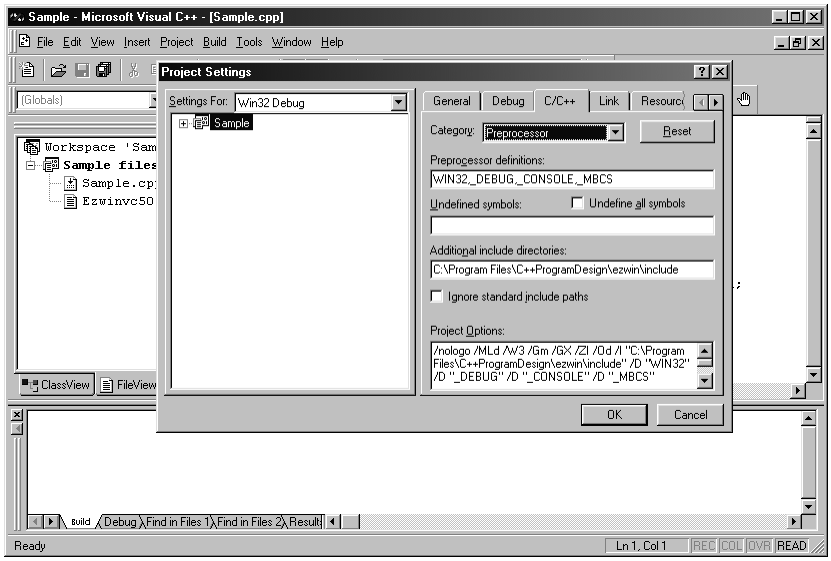
An EzWindows Program

```
#include <iostream>
using namespace std;
#include "ezwin.h"
int ApiMain() {
   SimpleWindow W("A Window", 12, 12);
   W.Open();

   cout << "Enter a character to exit" << endl;
   char a;
   cin >> a;

   return 0;
}
```

An EzWindows Project File



An EzWindows Project File



Sample Display Behavior

RectangleShape Objects

- EzWindows also provides **`RectangleShape`** for manipulating rectangles
- **`RectangleShape`** objects can specify the following attributes
  - **`SimpleWindow`** object that contains the rectangle (mandatory)
  - Offset from left edge of the **`SimpleWindow`**
  - Offset from top edge of the **`SimpleWindow`**
    - Offsets are measured in centimeters from rectangle center
  - Width in centimeters
  - Height in centimeters
  - Color
    - **`color`** is an EzWindows type

RectangleShape Objects

- Examples

```
SimpleWindow W1("My Window", 20, 20);
SimpleWindow W2("My Other Window", 15, 10);

RectangleShape R(W1, 4, 2, Blue, 3, 2);
RectangleShape S(W2, 5, 2, Red, 1, 1);
RectangleShape T(W1, 3, 1, Black, 4, 5);
RectangleShape U(W1, 4, 9);
```

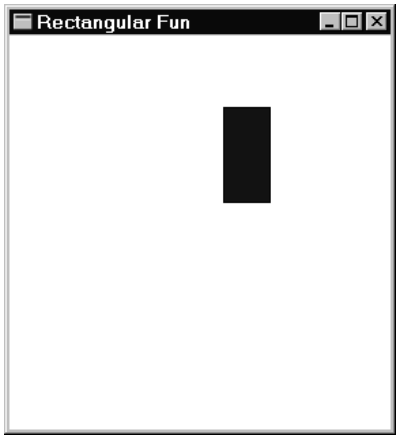
RectangleShape Objects

- Some **`RectangleShape`** member functions for processing messages
  - **`Draw()`**
    - Causes rectangle to be displayed in its associated window
  - **`GetWidth()`**
    - Returns width of object in centimeters
  - **`GetHeight()`**
    - Returns height of object in centimeters
  - **`SetSize()`**
    - Takes two attributes -- a width and height -- that are used to reset dimensions of the rectangle

Another EzWindows Program

```
#include <iostream>
using namespace std;
#include "rect.h"
int ApiMain()  {
   SimpleWindow W("Rectangular Fun", 12, 12);
   W.Open();
   RectangleShape R(W, 5.0, 2.5, Blue, 1, 2);
   R.Draw();
   cout << "Enter a character to exit" << endl;
   char Response;
   cin >> Response;
   return 0;
}
```

Sample Display Behavior



Compound Assignment

- C++ has a large set of operators for applying an operation to an object and then storing the result back into the object
- Examples

```
int i = 3;
i += 4;                    // i is now 7
cout << i << endl;

float a = 3.2;
a *= 2.0;                  // a is now 6.4
cout << a << endl;
```

Increment and Decrement

- C++ has special operators for incrementing or decrementing an object by one
- Examples

```
int k = 4;
++k;                              // k is 5
k++;                              // k is 6
cout << k << endl;
int i = k++;                      // i is 6, k is 7
cout << i << " " << k << endl;
int j = ++k;                      // j is 8, k is 8
cout << j << " " << k << endl;
```

Class string

- Some string member functions
  - size() determines number of characters in the string

```
string Saying = "Rambling with Gambling";
cout << Saying.size() << endl;        // 22
```

  - substr() determines a substring (Note first position has index 0)

```
string Word = Saying.substr(9, 4); // with
```

  - find() computes the position of a subsequence

```
int j = Saying.find("it");          // 10
int k = Saying.find("its");         // ?
```

Class string

- Auxiliary functions and operators
  - getline() extracts the next input line

```
string Response;
cout << "Enter text: ";
getline(cin, Response, '\n');
cout << "Response is \"" << Response
 << "\"" << endl;
```

  - Example run

```
Enter text: Want what you do
Response is "Want what you do"
```

Class string

- Auxiliary operators
  - + string concatenation

```
string Part1 = "Me";
string Part2 = " and ";
string Part3 = "You";
string All = Part1 + Part2 + Part3;
```

  - += compound concatenation assignment

```
string ThePlace = "Brooklyn";
ThePlace += ", NY";
```

```
#include <iostream>
using namespace std;
int main() {
   cout << "Enter the date in American format: "
    << "(e.g., January 1, 2001) : ";
      string Date;
   getline(cin, Date, '\n');
   int i = Date.find(" ");
   string Month = Date.substr(0, i);
   int k = Date.find(",");
   string Day = Date.substr(i + 1, k - i - 1);
   string Year = Date.substr(k + 2, Date.size() - 1);
   string NewDate = Day + " " + Month + " " + Year;
   cout << "Original date: " << Date << endl;
   cout << "Converted date: " << NewDate << endl;
   return 0;
}
```