Reference

C++ Object Oriented Programming

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NTOU CS

Contents

- What is reference in C++?
- Concept of an alias
- Initialization of a reference
- Reference can replace a pointer but is not a pointer
- Function that can be used as an l-value
- Reference can be used to increase efficiency
- Reference as a member variable
- Reference in copy constructor X(X&)

References

- C simulates “call by reference” through pointers

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void func(int *ptrData) {
    *ptrData = 10;
}
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```
void main() {
    int data;
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    func(&data);
    …
}
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no dereference operator required

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It is also the goal of C++ **to reduce the usage of pointers**.

- Some C++ programmers might do the following for saving time and memory in passing arguments.

```
void foo(const CBigData &data) {
    …
}
```

References (cont’d)

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    data = 10;
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void main() {
    int data;
    …
    func(data);
    …
}
```

References (cont'd)

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error C2664: 'func' : cannot convert parameter 1 from 'int' to 'double &'

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```
int getValue() {
    int tmp;
    return tmp;
}
int func(int &value);
void main() {
    func(getValue());
}
```

References (cont'd)

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void func(double &data) {
    data = 10;
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void main() {
    int data;
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```
int getValue() {
    int tmp;
    return tmp;
}
int func(int &value);
void main() {
    func(getValue());
}
```

int func(const int &value) is OK

error C2664: 'func' : cannot convert parameter 1 from 'int' to 'int &'

References as Aliases

- A reference is an **alias to another variable (lvalue).**

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```
void main {
    int x = 5;
    int &alias = x;
    cout << "The value of x is " << x << endl;
    cout << "The value of the alias is " << alias << endl;
    alias = 10;
    cout << "The value of x is " << x << endl;
    cout << "The value of the alias is " << alias << endl;
}
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lvalue is an expression that refers an object, e.g. variable, array cell, or dereferenced pointer, that persists beyond a simple expression

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Error: 'const' or '&' variable needs initializer

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Note: Initialization and assignment are different.

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int &aliasX = x;
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```
int x = 5;
int y = 5;
int &aliasX = x;
int &aliasY = y;
if (aliasX == aliasY)
    cout << "identical.\n";
else
    cout << "different\n";
```

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int x = 5;
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int *ptrX = &x;
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Output: identical

comparing the contents of x and y

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Output: different

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References are not Pointers (cont'd)

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```
int x = 5;
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```
int x = 5;
int *ptr;
int &alias = x;
ptr = &alias;
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There are only two variables in this code segment. **ptr** contains the address of **x** (not the address of *alias*. Indeed *alias* itself is not a variable.)

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int array[] = {3, 2, 1};
int &alias = array[0];
alias++;
cout << alias << '\n' << array[0] << '\n';
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Output:

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    char *string = "hello";
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}
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void main() {
    char *string = "hello";
    Foo(string);
    cout << string;
}
```

```
void Foo(char* &strPtrRef) {
    strPtrRef = "good day";
}
```

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int array[] = {3, 2, 1};
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cout << alias << '\n' << array[0] << '\n';
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Output:
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    cout << string;
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Output:
good day

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```
void main() {
    int array[] = {1, 2, 3};
    cout << pArray(array, 2) << '\n';
    pArray(array, 1) = 10;
    cout << pArray(array, 1) << ' ' << array[0] << '\n';
}
```

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```

Output:

```
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    cout << pArray(array, 2) << '\n';
    pArray(array, 1) = 10;
    cout << pArray(array, 1) << ' ' << array[0] << '\n';
}
int &pArray(int cArray[], int index) {
    return cArray[index-1];
}
```

Output:

```
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10 10
```

Function Returning a Reference

- Assuming that you want to emulate a Pascal-style 1-based array:

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void main() {
    int array[] = {1, 2, 3};
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}
int &pArray(int cArray[], int index) {
    return cArray[index-1];
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```

Output:
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10 10

- The ‘function call’ **pArray(array, 2)** is used like an **lvalue**.

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    cout << pArray(2) << '\n';
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    cout << pArray(2) << '\n';
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    cout << pArray(1) << '\n';
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```

Output:

2

1

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    int cArray[] = {1, 2, 3};
    return cArray[index-1];
}
void main() {
    cout << pArray(2) << '\n';
    pArray(1) = 10;
    cout << pArray(1) << '\n';
}
```

Output:
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1

This code is likely to crash with memory access error.

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BigDataT x, y;
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Foo(x, y);
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Reference Saves Computation

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```
BigDataT x, y;
…
Foo(x, y);
…

void Foo(const BigDataT &inputData, BigDataT &outputData) {
  …
  inputData.accessor(); // access the aliased variable x by inputData directly
  …                     // without changing it
  outputData.mutator(); // access y directly and modify its value
  …
}
```

References as Data Members

```
class Patron {
public:
    Patron(double &limit);
    void Charge(double amount);
private:
    const double &fCreditLimit;
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class Patron {
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Patron::Patron(double &limit): fCreditLimit(limit) {
    …
}
```

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Initialization-list:
the only way to initialize
a reference member
or a const member variable

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    const double &fCreditLimit;
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    …
}

double customerCreditLimit = 1000;
…
Patron patron(customerCreditLimit);
…
```

Initialization-list:
the only way to initialize
a reference member
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The Hidden Perils of C++

```
class String {
public:
    String();
    String(const char *inputStr);
    ~String();
    const char *GetString() const;
private:
    char *fString;
};
```

The Hidden Perils of C++

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class String {
public:
    String();
    String(const char *inputStr);
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    const char *GetString() const;
private:
    char *fString;
};

String::String(char *inputStr) {
    fString = new char[strlen(inputStr)+1];
    strcpy(fString, inputStr);
}
```

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String::~String() {
    delete[] fString;
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    strcpy(fString, inputStr);
}

String::~String() {
    delete[] fString;
}
```

```
void main() {
    String string1("Hello");
    {
        String string2 = string1;
        cout << string2.GetString() << endl;
    }
    cout << string1.GetString() << endl;
}
```

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    String();
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void main() {
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        String string2 = string1;
        cout << string2.GetString() << endl;
    }
    cout << string1.GetString() << endl;
}
```

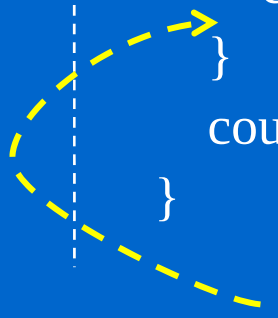

destruct string2 and also the allocated memory of string1

The Hidden Perils of C++

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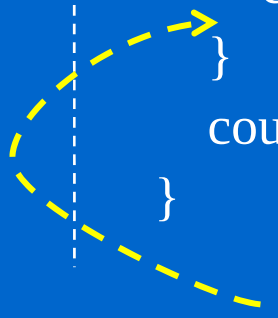
    String();
    String(const char *inputStr);
    ~String();
    const char *GetString() const;
private:
    char *fString;
};

String::String(char *inputStr) {
    fString = new char[strlen(inputStr)+1];
    strcpy(fString, inputStr);
}

String::~String() {
    delete[] fString;
}
```

```
void main() {
    String string1("Hello");
    {
        String string2 = string1;
        cout << string2.GetString() << endl;
    }
    cout << string1.GetString() << endl;
}
```



destruct string2 and also the allocated memory of string1

This piece of code often makes your program crash. The lack of explicit **copy constructor** creates two pointers pointing to the same piece of memory.

Copy Ctor **X(X&)**, **X(const X&)**

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  2. String string2(string1);
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```
string fun(string stringParam) {
    …
    return string("hello");
}
```

Array of References is Illegal

```
void fun(int &array[]) {
    int i;
    for (i=0; i<10; i++)
        array[i] = i;
}
```

```
void main() {
    int i, array[10];
    fun(array);
}
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```
void fun1(int **&dptr) {
    dptr = (int **) new int*[10];
}
void fun2(int ***tptr) {
    *tptr = (int **) new int*[10];
}
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```
void main() {
    int **doublePtr1, **doublePtr2;
}
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    *tptr = (int **) new int*[10];
}
```

```
void main() {
    int **doublePtr1, **doublePtr2;
    fun1(doublePtr1);
}
```

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    int i;
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}
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}
```

```
void main() {
    int **doublePtr1, **doublePtr2;
    fun1(doublePtr1);
    fun2(&doublePtr2);
}
```

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void fun(int &array[]) {
    int i;
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void main() {
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}
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Equivalent, but less readable