C++ For C Coders 3

Data Structures
C++ for C Coders

한동대학교 김영섭교수
idebtor@gmail.com

Default function arguments
Reference operator
const, const reference
new and delete operator
command line processing

Default Function Arguments

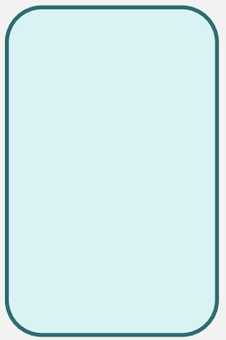
- In calling of the function, if the arguments are not given, default values are used.

```
int exp(int n, int k = 2) {
  if (k == 2) return (n * n);
  return (exp(n, k - 1) * n);
}
```

Default Function Arguments

- In calling a function argument must be given from left to right without skipping any parameter

```
void foo(int i, int j=7);                  // right
void goo(int i=3, int j);                  //
void hoo(int i, int j=3, int k=7);         //
void moo(int i=1, int j=2, int k=3);       //
void noo(int i=2, int j, int k=3);         //
```



Default Function Arguments

- In calling a function argument must be given from left to right without skipping any parameter

```
void foo(int i, int j=7);                  // right
void goo(int i=3, int j);                  // wrong
void hoo(int i, int j=3, int k=7);         // right
void moo(int i=1, int j=2, int k=3);       // right
void noo(int i=2, int j, int k=3);         // wrong
```

Reference Operator &

- A reference allows to declare an alias to another variable.
- If the **aliased** variable lives, you can use indifferently the variable or the alias.

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

int main() {
  int x;
  int& foo = x;
  foo = 49;
  cout << x << endl;
  retrn 0
}
```

Reference Operator &

- A reference allows to declare an alias to another variable.
- References are **extremely useful** when used with function arguments since it saves the cost of copying parameters into the stack when calling the function.

Reference Operator &

- Swap() in C

```
void swap(____________________) {
  int temp = ________

  ____________

  ____________
}
```

```
int main() {
  int i = 3, j = 5;
  swap(____________);
  printf("%d, %d\n", i, j);
}
```

& is an address operator.

Solution in C

```
5  3
```

Reference Operator &

- Swap() in C

```
void swap(____________________) {
  int temp = ________

  ____________

  ____________
}
```

```
int main() {
  int i = 3, j = 5;
  swap(____________);
  printf("%d, %d\n", i, j);
}
```

& is an address operator.

Solution in C

```
void swap(int *a, int *b) {
  int temp = *a;
  *a = *b;
  *b = temp;
}
```

```
int main() {
  int i = 3, j = 5;
  swap(&i, &j);
  printf("%d, %d\n", i, j);
}
```

5 3

Reference Operator &

- Swap() in C++

```
void swap(_________________) {
  int temp = ________

  ____________

  ____________
}
```

```
int main() {
  int i = 3, j = 5;
  swap(____________);
  cout << i << " " << j << endl;
}
```

& is a reference operator.

Solution in C++

Reference Operator &

- Swap() in C++

```
void swap(__________________) {
  int temp = ________

  ____________

  ____________
}
```

```
int main() {
  int i = 3, j = 5;
  swap(____________);
  cout << i << " " << j << endl;
}
```

& is a reference operator.

Solution in C++

```
void swap(int& a, int& b) {
  int temp = a;
  a = b;
  b = temp;
}
```

```
int main() {
  int i = 3, j = 5;
  swap(i, j);
  cout << i << " " << j << endl;
}
```

& is a reference operator.

Comparison: Using pointer * and reference &

- Comparison

C

```
void swap(int *a, int *b) {
  int temp = *a;
  *a = *b;
  *b = temp;
}
```

```
int main() {
  int i = 3, j = 5;
  swap(&i, &j);
  printf("%d, %d\n", i, j);
}
```

& is an address operator.

C++

```
void swap(int& a, int& b) {
  int temp = a;
  a = b;
  b = temp;
}
```

```
int main() {
  int i = 3, j = 5;
  swap(i, j);
  cout << i << " " << j << endl;
}
```

& is a reference operator.

No Function Overloading in C

- Function overloading is a feature of object-oriented programming where two or more functions can have the same name but different parameters.

This code would **not** work since no overloading supported in C

```
int main() {
  int i = 3, j = 5;
  swap(&i, &j);
  printf("%d, %d\n", i, j);

  double x = 3, y = 5;
  swap(&x, &y);
  printf("%f, %f\n", x, y);
}
```

```
void swap(int *a, int *b) {
  int temp = *a;
  *a = *b;
  *b = temp;
}

void swap(double *a, double *b) {
  double temp = *a;
  *a = *b;
  *b = temp;
}
```

Function Overloading in C++

- Function overloading is a feature of object-oriented programming where two or more functions can have the same name but different parameters.

C++ Function overloading

```
int main() {
  int i = 3, j = 5;
  swap(i, j);
  cout << i << " " << j << endl;

  double x = 3, y = 5;
  swap(x, y);
  cout << x << " " << y << endl;
}
```

```
void swap(int& a, int& b) {
  int temp = a;
  a = b;
  b = temp;
}

void swap(double& a, double& b) {
  double temp = a;
  a = b;
  b = temp;
}
```

const Reference

- To prevent the function from changing the parameter accidentally, we pass the argument as **constant reference** to the function.

```
struct Person {
  char name[40];
  int age;
};
void print(Person k){
  cout << "Name: " << k.name << endl;
  cout << "Age: " << k.age << endl;
}

int main(){
  Person man{"Adam", 316};
  print(man);
  return 0;
}
```

C style coding in C++

const Reference

- To prevent the function from changing the parameter accidentally, we pass the argument as **constant reference** to the function.

```
struct Person {
  char name[40];
  int age;
};
void print(const Person& k) {
  cout << "Name: " << k.name << endl;
  cout << "Age: " << k.age << endl;
}

int main(){
  Person man{"Adam", 316};
  print(man);
  return 0;
}
```

C style coding in C++

k is constant reference parameter

What is good about passing by const reference?

- Instead of 44 bytes, only 4 byes (address) are sent to the function.
- Calling function knows that Person k would not be changed.

Return by reference

- By default in C++, when a function returns a value, it is copied into stack. The calling function reads this value from stack and copies it into its variables.
- An alternative to "return by value" is "return by reference", in which the value returned is not copied into stack.
- One result of using "return by reference" is that the function which returns a parameter by reference **can be used on the left side of an assignment** statement.

```
funcReturnByRef(a_parm) = a_value;
```

the left side of an assignment

Return by reference

- Modify the following programs such that it sets the maximum element to zero.

```
int max(int a[], int n) {
  int x = 0;
  for (int i = 0 ; i < n; i++)
    if (a[i] > a[x]) x = i;
  return a[x];
}

int main() {
  int a[] = {12, 42, 33, 99, 63};
  int n = 5;

  for (int i = 0; i < n; i++)
    cout << a[i] << " ";
}
```

12 42 33 0 63

Return by reference

- Modify the following programs such that it sets the maximum element to zero.

```
int& max(int a[], int n) {    // returns an integer reference of the max element
  int x = 0;
  for (int i = 0; i < n; i++)
    if (a[i] > a[x]) x = i;
  return a[x];
}

int main() {
  int a[] = {12, 42 , 33 , 99, 63};
  int n = 5;
  max(array,5) = 0;           // overwrite the max element with 0
  for (int i = 0; i < n; i++)
    cout << a[i] << " ";
}
```

the function returns by the reference
it can be the left side of an assignment

12 42 33 0 63

Never return a local variable by reference

- Since a function that uses "return by reference" returns an actual memory address, it is important that the variable in this memory location remain in existence after the function returns.

```
int& foo() {
  int i;
  ...
  return i;                    // ERROR! does not exist anymore
```

- Local variables can be return by their values

```
int foo() {
  int i;                       // Local variable, created in stack
  ...
  return i;                    // OK! does not exist anymore
```

malloc & free vs new & delete

- In C, dynamic memory allocation is done with malloc() and free().
- The C++ new and delete operators performs dynamic memory allocation.

```
int *p = (int *)malloc(sizeof(int) * N);

for (int i = 0; i < N; i++)
  p[i] = i;

free(p);
```

```
int *p = new int[N];

for (int i = 0; i < N; i++)
  p[i] = i;

delete[] p;
```

Using new & delete

- The **new** operator allocates memory and **delete** frees it.

```
int *pi = new int;                    // pi points to uninitialized int
int *pi = new int(7);                 // which pi points has value 7
string *ps = new string("hello");  // ps points "hello", cout << *ps << endl;
string st = "hello";                  // string st("hello"), cout << st << endl;

int *pia = new int[7];                // block of seven uninitialized ints
int *pia = new int[7]();              // block of seven ints values initialized to 0

string *psa = new string[5];                 // block of 5 empty strings
string *psa = new string[5]();               // block of 5 empty strings
int    *pia = new int[5]{0, 1, 2, 3, 4};  // block of 5 ints initialized
string *psa = new string[2]{"a", "the"};  // block of 2 strings initialized
delete   pi;
delete[] pia;
```

Command line processing

- Open Atom editor
  - Filename: **`args.cpp`**
  - Add the source code.
  - Save the file.
- Compile and Execute

```
$ g++ args.cpp -o args
$ ./args Why not change the world?
```

- Read more about this in github: **`/nowic/ArgcArgv.md`**
- Write a function **`args_to_strs()`** that returns an array of strings to replace both argc and argv;
  - **Use `vector<string>`**
- Once you complete it, move the function into a new file called **`args_to.cpp`**.
- Test **`args.cpp`** and **`args_to.cpp`**.

```
// args.cpp
#include <iostream>
using namespace std;

int main(const int argc, char** argv) {
  cout << "You entered: "
       << argc << " arguments:" << endl;

  for (int i = 0; i < argc; ++i)
    cout << argv[i] << endl;
  return 0;
}
```

Multiple Source Files

- If you have multiple files to compile and link, for example,
  - Filename: **`args.cpp`**
  - Filename: **`args_to.cpp`**

- Compile and execute

```
$ g++ args.cpp args_to.cpp -o args
$ ./args
```

(3)

C++ For C Coders 3

Data Structures
C++ for C Coders

한동대학교 김영섭교수
idebtor@gmail.com

Default Arguments
Reference Operator
const
new and delete operator
command line processing