CISC 1600/1610 Computer Science I

Functions: scope and pass-by-reference

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Variable scope

Variables declared in a function

- are **local** to that function
- are invisible to all other functions

`int main()` is a function

What does this code do?

```
int newFunc(int a);

int main() {
  int a=5, b, c=5;
  b = newFunc(a);
  cout << a << " " << b << " "
       << c << endl;
  return 0;
}

int newFunc(int a) {
  int c=12;
  return a*5+c;
}
```


Formal parameters

"Formal parameters" are the variables in the function head

```
float triple(float inNum)
{
   float tripledNum;
   tripledNum=3*inNum;
   return tripledNum;
}
```

Function head

Function body

Formal parameters

- **Local** to the function
- Used as if they were declared in function body – **do not** re-declare in function body
- When function is called, parameters initialized to the values of the arguments in the function call

```
float triple(float inNum)
{
   float tripledNum;
   tripledNum=3*inNum;
   return tripledNum;
}
```


Formal parameter names

- Parameter names do not have to match names of variables used in function call
- Different programmer can write `int main()` and functions used by `int main()`

Broader scope: global variables

- Global variables visible to all functions
- Declared outside of all functions
- Must be declared prior to first use

```
#include<iostream>
using namespace std;
const float PI=3.14;
    // visible to main and to areaCircle

// compute area of circle
float areaCircle(float radius);

int main() { ...}
float areaCircle(float radius) {...}
```

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More on global variables

- Useful to define global constants
- Very risky to define non-constant global variables
  - try to keep track of what functions change the variable

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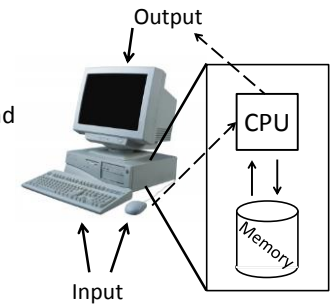
Computer system structure

Central processing unit (CPU) – performs all the instructions

Memory – stores data and instructions for CPU

Input – collects information from the world

Output – provides information to the world



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The binary representation

- Each variable is represented by a certain number of 0s and 1s
- Each 0-or-1 is a bit
- 8 bits in a row is a byte

`int numStudents = 33;` assigns a binary code to memory: `00000000000000000000000000001100`

$$2^3x1 + 2^2x1 + 2^1x0 + 2^0x0$$
$$8x1 + 4x1 + 2x0 + 1x0$$
$$14$$

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Variable types, revisited

`char`	single character ('a', 'Q')	1 byte
`int`	integers (-4, 82)	4 bytes
`bool`	logic (true or false)	1 byte
`float`	real numbers (1.3, -0.45)	4 bytes
`string`	text ("Hello", "reload")	? bytes
`vector`	sequence of values ({16,5}, {-2.3,3.4,-0.4})	? bytes

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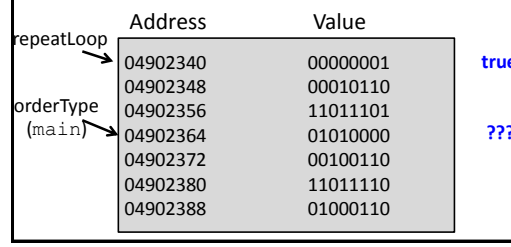
Variables – locations in memory

- Each variable indicates a location in memory
- Each location holds a value
- Value can change as program progresses



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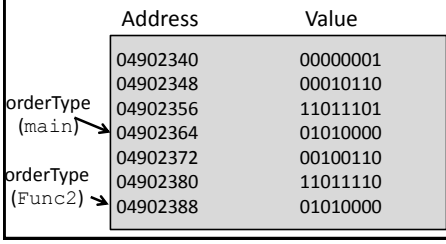
Memory usage by functions

"Call-by-value":

- provide function with the value held in a variable input
- assign value to new internal variable



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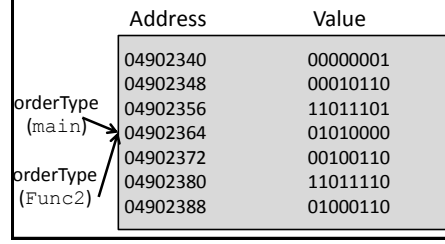
Memory usage by functions

"Call-by-reference":

- provide function with the **address** of a variable input
- assign value into old address



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Call-by-Reference Syntax

- Use & to indicate a variable is called by reference
- Use & both in declaration and definition

```
void get_letters(char& letter1, char& letter2);

...

void get_letters(char& letter1, char& letter2)
{
   cout << "Enter two letters: ";
   cin >> letter1 >> letter2;
}
```

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Call-by-reference vs. Call-by-value

- Call-by-value preserves the value of the original input argument
- Call-by-reference can change the value of the original input argument
  - Effectively allows return of multiple values from function

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```
int mysteryFunc(int& num1);

int main() {
  int a=5;
  cout << mysteryFunc(a) << endl;
  cout << a << endl;
  return 0;
}

int mysteryFunc(int &num1) {
  num1 += 3;
  return num1/4;
}
```

What does this do?

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```
int mysteryFunc2(int inNum);

int main() {
  int a=3;
  cout << mysteryFunc2(a);
  cout << a;
  return 0;
}

int mysteryFunc2(int inNum) {
  inNum = inNum*inNum;
  return inNum;
}
```

What does this do?

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Call-by-reference: Input arguments

- Arguments must be variables
  If declare: `void myFunc(float& inputNum);`
  - `myFunc(inVariable);` - GOOD syntax
  - `myFunc(25.4);` - BAD syntax

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Mixing parameters

- Can define a function that takes both values and references

```
void flipAndMult(int& num1, int& num2, int mult);
// flips num1 and num2 and multiplies each
// by mult
```

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More usage of &

```
int x = 5;
int& y=x; // y and x point to same address
y=10;
cout << x << endl; // output x value
cout << &x << endl; // output x address
```

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