Lecture 8

Functions

QUIZ

سورة طه پارہ: 16

قَالَ رَبِّ اشْرَحْ لِيْ صَدْرِيْ ۙ ﴿٢٥﴾

[قَالَ: اس نے کہا] [رَبِّ: اے رب !] [اشْرَحْ: کھول دے] [لِيْ: میرے لیے] [صَدْرِيْ : میرا سینہ]

وَيَسِّرْ لِيْٓ اَمْرِيْ ۙ ﴿٢٦﴾

[وَيَسِّرْ: اور آسان کر دے] [لِيْ: میرے لیے] [اَمْرِيْ : میرا کام]

وَاحْلُلْ عُقْدَةً مِّنْ لِّسَانِيْ ۙ ﴿٢٧﴾

[وَاحْلُلْ: اور کھول دے] [عُقْدَةً: گرہ] [مِّنْ: سے] [لِّسَانِيْ: میری زبان]

يَفْقَهُوْا قَوْلِيْ ۖ ﴿٢٨﴾

[يَفْقَهُوْا: وہ سمجھ سکیں] [قَوْلِيْ : میری بات]

QUESTIONS / FEEDBACK / CONCERNS

UBS

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SE SEC A
SLIDE OF FAME

NO ONE
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WEEK-2

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Muhammad Mukarram
BSSE23029
WEEK-1

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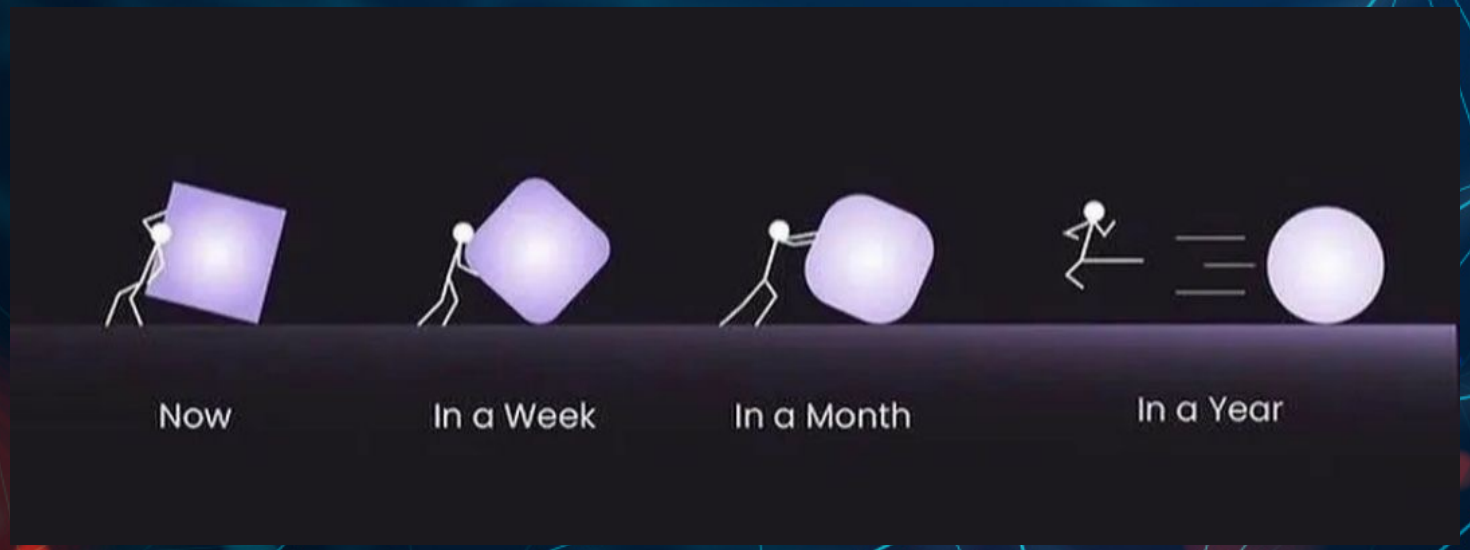

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RECAP

GitHub

Tools (Cygwin, IDE, GitHub)

Flowcharts

Algorithms

Approach towards a word problem

Pseudocode

Flowcharts Advantages & Disadvantages

Numbers Systems (Decimal, Binary, Octal & Hexadecimal)

Ten’s Complement

Twos Complement

main function

Stream in and stream out operators

if else

Functions

Data Types

Arithmetic Operators

Relational Operators

Loops (While, for , do while)

Switch cases

INFINITE LOOP

```
while(true)
{
    statement(s)
}
```

How can we print Table of 13 till 10?

Eg.

13 x 1 = 13

13 x 2 = 26

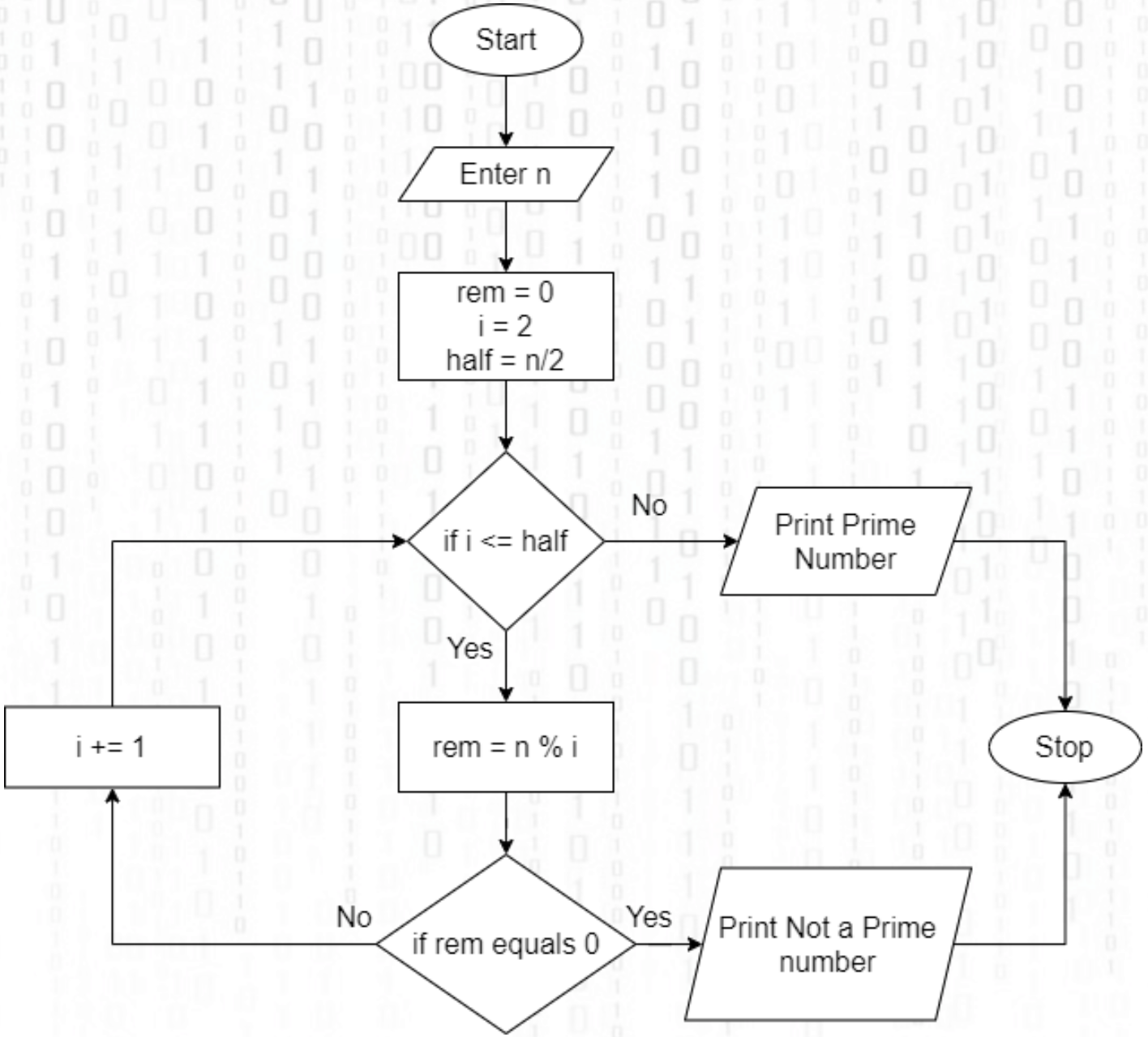
.

.

.

13 x 10 = 130

Check whether a number is prime or not.



```cpp
#include <iostream>
using namespace std;
int main() {
  int threeExpFour = 1;
  for (int i = 0; i < 4; i = i + 1) {
    threeExpFour = threeExpFour * 3;
  }
  cout << "3^4 is " << threeExpFour << endl;
  return 0;
}
```

```
#include <iostream>
using namespace std;
int main() {
int threeExpFour = 1;
for (int i = 0; i < 4; i = i + 1) {
threeExpFour = threeExpFour * 3;
}
cout << "3^4 is " << threeExpFour << endl;
int sixExpFive = 1;
for (int i = 0; i < 5; i = i + 1) {
sixExpFive = sixExpFive * 6;
}
cout << "6^5 is " << sixExpFive << endl;
return 0;
}
```

Copy-paste coding (bad)

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

int main() {
  int threeExpFour = 1;
  for (int i = 0; i < 4; i = i + 1) {
    threeExpFour = threeExpFour * 3;
  }
  cout << "3^4 is " << threeExpFour << endl;
  int sixExpFive = 1;
  for (int i = 0; i < 5; i = i + 1) {
    sixExpFive = sixExpFive * 6;
  }
  cout << "6^5 is " << sixExpFive << endl;
  int twelveExpTen = 1;
  for (int i = 0; i < 10; i = i + 1) {
    twelveExpTen = twelveExpTen * 12;
  }
  cout << "12^10 is " << twelveExpTen << endl;
  return 0;
}
```

With a function

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

// some code which raises an arbitrary integer
// to an arbitrary power

int main() {
  int threeExpFour = raiseToPower(3, 4);
  cout << "3^4 is " << threeExpFour << endl;
  return 0;
}
```

With a function

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

// some code which raises an arbitrary integer
// to an arbitrary power

int main() {
  int threeExpFour = raiseToPower(3, 4);
  cout << "3^4 is " << threeExpFour << endl;
  int sixExpFive = raiseToPower(6, 5);
  cout << "6^5 is " << sixExpFive << endl;
  return 0;
}
```

With a function

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

// some code which raises an arbitrary integer
// to an arbitrary power

int main() {
  int threeExpFour = raiseToPower(3, 4);
  cout << "3^4 is " << threeExpFour << endl;
  int sixExpFive = raiseToPower(6, 5);
  cout << "6^5 is " << sixExpFive << endl;
  int twelveExpTen = raiseToPower(12, 10);
  cout << "12^10 is " << twelveExpTen << endl;
  return 0;
}
```

Why define your own functions?

- Readability: sqrt(5) is clearer than copy-pasting in an algorithm to compute the square root
- Maintainability: To change the algorithm, just change the function (vs changing it everywhere you ever used it)
- Code reuse: Lets other people use algorithms you've implemented

Function Declaration Syntax

Function name

```
int raiseToPower(int base, int exponent)
{
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1)
    { result = result * base;
  }
  return result;
}
```

Function Declaration Syntax

Return type

```
int raiseToPower(int base, int exponent)
{
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1)
    { result = result * base;
  }
  return result;
}
```

Function Declaration Syntax

Argument 1

```
int raiseToPower(int base, int exponent)
{
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1) {
    result = result * base;
  }
  return result;
}
```

- Argument order matters:
  - raiseToPower(2,3) is 2^3=8
  - raiseToPower(3,2) is 3^2=9

Function Declaration Syntax

Argument 2

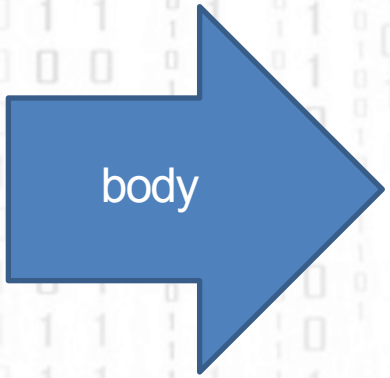
```
int raiseToPower(int base, int exponent)
{
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1) {
    result = result * base;
  }
  return result;
}
```

- Argument order matters:
  - raiseToPower(2,3) is 2^3=8
  - raiseToPower(3,2) is 3^2=9

Function Declaration Syntax


```
int raiseToPower(int base, int exponent)
{
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1) {
    result = result * base;
  }
  return result;
}
```

Function Declaration Syntax




```
int raiseToPower(int base, int exponent)
{
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1)
    { result = result * base;
  }
  return result;
}
```

Function Declaration Syntax

```
int raiseToPower(int base, int exponent)
{
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1) {
    result = result * base;
  }
  return result;
}
```

Return statement

Function declaration

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

int raiseToPower(int base, int exponent) {
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1) {
    result = result * base;
  }
} return result;

int main() {
  int threeExpFour = raiseToPower(3, 4);
  cout << "3^4 is " << threeExpFour << endl;
  return 0;
}
```

Function invocation

Returning a value

- Up to one value may be returned; it must be the same type as the return type.

```
int foo()
{
  return "hello";      // error

}
```

```
char* foo()
{
  return "hello"; // ok

}
```

Returning a value

- Up to one value may be returned; it must be the same type as the return type.
- If no values are returned, give the function a **void** return type

```
void printNumber(int num) {
  cout << "number is " << num << endl;
}

int main() {
  printNumber(4); // number is 4
  return 0;
}
```

Returning a value

- Up to one value may be returned; it must be the same type as the return type.
- If no values are returned, give the function a **void** return type
  - Note that you cannot declare a variable of type void

```
int main() {
  void x; // ERROR
  return 0;
}
```

Returning a value

- Return statements don't necessarily need to be at the end.
- Function returns as soon as a return statement is executed.

```
void printNumberIfEven(int num) {
  if (num % 2 == 1) {
    cout << "odd number" << endl;
    return;
  }
  cout << "even number; number is " << num << endl;
}

int main() {
  int x = 4;
  printNumberIfEven(x);
  // even number; number is 3
  int y = 5;
  printNumberIfEven(y);
  // odd number
```

Argument Type Matters

```
void printOnNewLine(int x)
{
    cout << x << endl;
}
```

- `printOnNewLine(3)` works
- `printOnNewLine("hello")` will not compile

Argument Type Matters

```
void printOnNewLine(char *x)
{
    cout << x << endl;
}
```

- `printOnNewLine(3)` will not compile
- `printOnNewLine("hello")` works

Argument Type Matters

```
void printOnNewLine(int x)
{
    cout << x << endl;
}

void printOnNewLine(char *x)
{
    cout << x << endl;
}
```

- `printOnNewLine(3)` works
- `printOnNewLine("hello")` also works

Function Overloading

```
void printOnNewLine(int x)
{
    cout << "Integer: " << x << endl;
}

void printOnNewLine(char *x)
{
    cout << "String: " << x << endl;
}
```

- Many functions with the same name, but different arguments
- The function called is the one whose arguments match the invocation

Function Overloading

```
void printOnNewLine(int x)
{
    cout << "Integer: " << x << endl;
}

void printOnNewLine(char *x)
{
    cout << "String: " << x << endl;
}
```

- printOnNewLine(3) prints “Integer: 3”
- printOnNewLine(“hello”) prints “String: hello”

Function Overloading

```
void printOnNewLine(int x)
{
    cout << "1 Integer: " << x << endl;
}

void printOnNewLine(int x, int y)
{
    cout << "2 Integers: " << x << " and " << y << endl;
}
```

- printOnNewLine(3) prints “1 Integer: 3”
- printOnNewLine(2, 3) prints “2 Integers: 2 and 3”

- Function declarations need to occur before invocations

```
int foo()
{
    return bar()*2; // ERROR - bar hasn't been declared yet
}

int bar()
{
    return 3;
}
```

- Function declarations need to occur before invocations
  - Solution 1: reorder function declarations

```
int bar()
{
    return 3;
}

int foo()
{
    return bar()*2; // ok
}
```

- Function declarations need to occur before invocations
  - Solution 1: reorder function declarations
  - Solution 2: use a function prototype; informs the compiler you'll implement it later

```
int bar();

int foo()
{
    return bar()*2; // ok
}

int bar()
{
    return 3;
}
```

- Function prototypes should match the signature of the method, though argument names don't matter

```
int square(int);

int cube(int x)
{
    return x*square(x);
}

int square(int x)
{
    return x*x;
}
```

- Function prototypes should match the signature of the method, though argument names don't matter

```
int square(int x);

int cube(int x)
{
    return x*square(x);
}

int square(int x)
{
    return x*x;
}
```

- Function prototypes should match the signature of the method, though argument names don't matter

```
int square(int z);

int cube(int x)
{
    return x*square(x);
}

int square(int x)
{
    return x*x;
}
```

- Function prototypes are generally put into separate header files
  - Separates specification of the function from its implementation

```
// myLib.h - header
// contains prototypes

int square(int);
int cube (int);
```

```
// myLib.cpp - implementation
#include "myLib.h"

int cube(int x)
{
    return x*square(x);
}

int square(int x)
{
    return x*x;
}
```

Global Variables

- How many times is function foo() called? Use a global variable to determine this.
  - Can be accessed from any function

```
int numCalls = 0;

void foo() {
  ++numCalls;
}

int main() {
  foo(); foo(); foo();
  cout << numCalls << endl;
}
```

Scope

- Scope: where a variable was declared, determines where it can be accessed from

```
int numCalls = 0;
int raiseToPower(int base, int exponent) {
        numCalls = numCalls + 1;
        int result = 1;
        for(int i = 0; i < exponent; i = i +1)
        {
            result= result * base;
        }
        return result;
}

int max(int num1, int num2)
{ numCalls = numCalls + 1;
  int result;
  if(num1> num2)
     result = num1;
  else
     result = num2;
  return result;
}
```

Scope

- Scope: where a variable was declared, determines where it can be accessed from
- numCalls has global scope – can be accessed from any function

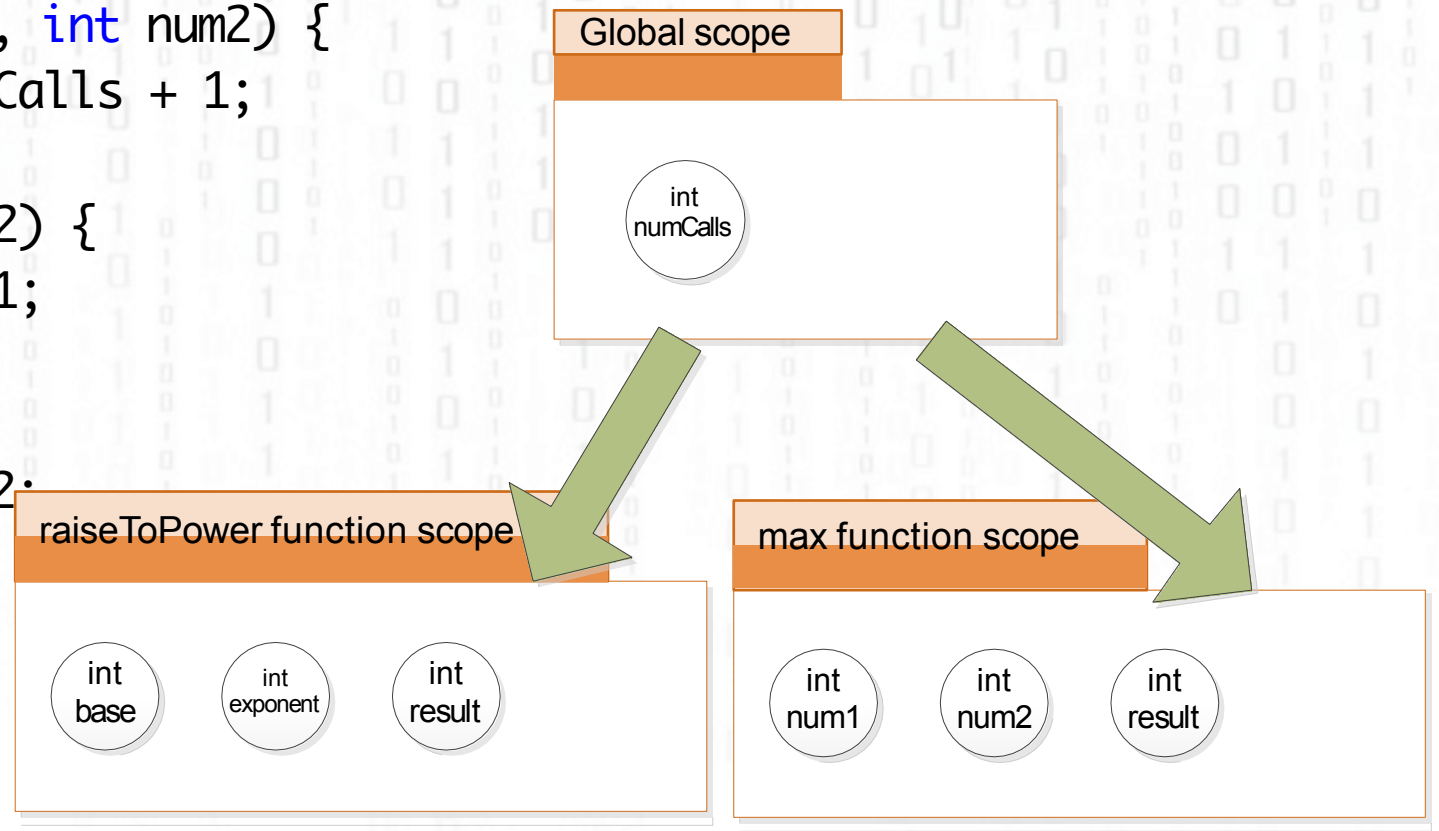
```
int numCalls = 0;
int raiseToPower(int base, int exponent) {
        numCalls = numCalls + 1;
        int result = 1;
        for(int i = 0; i < exponent; i = i +1)
        {
            result= result * base;
        }
        return result;
}

int max(int num1, int num2)
{ numCalls = numCalls + 1;
  int result;
  if(num1> num2)
     result = num1;
  else
     result = num2;
  return result;
}
```

Scope

- Scope: where a variable was declared, determines where it can be accessed from
  - numCalls has global scope – can be accessed from any function
  - result has function scope – each function can have its own separate variable named result

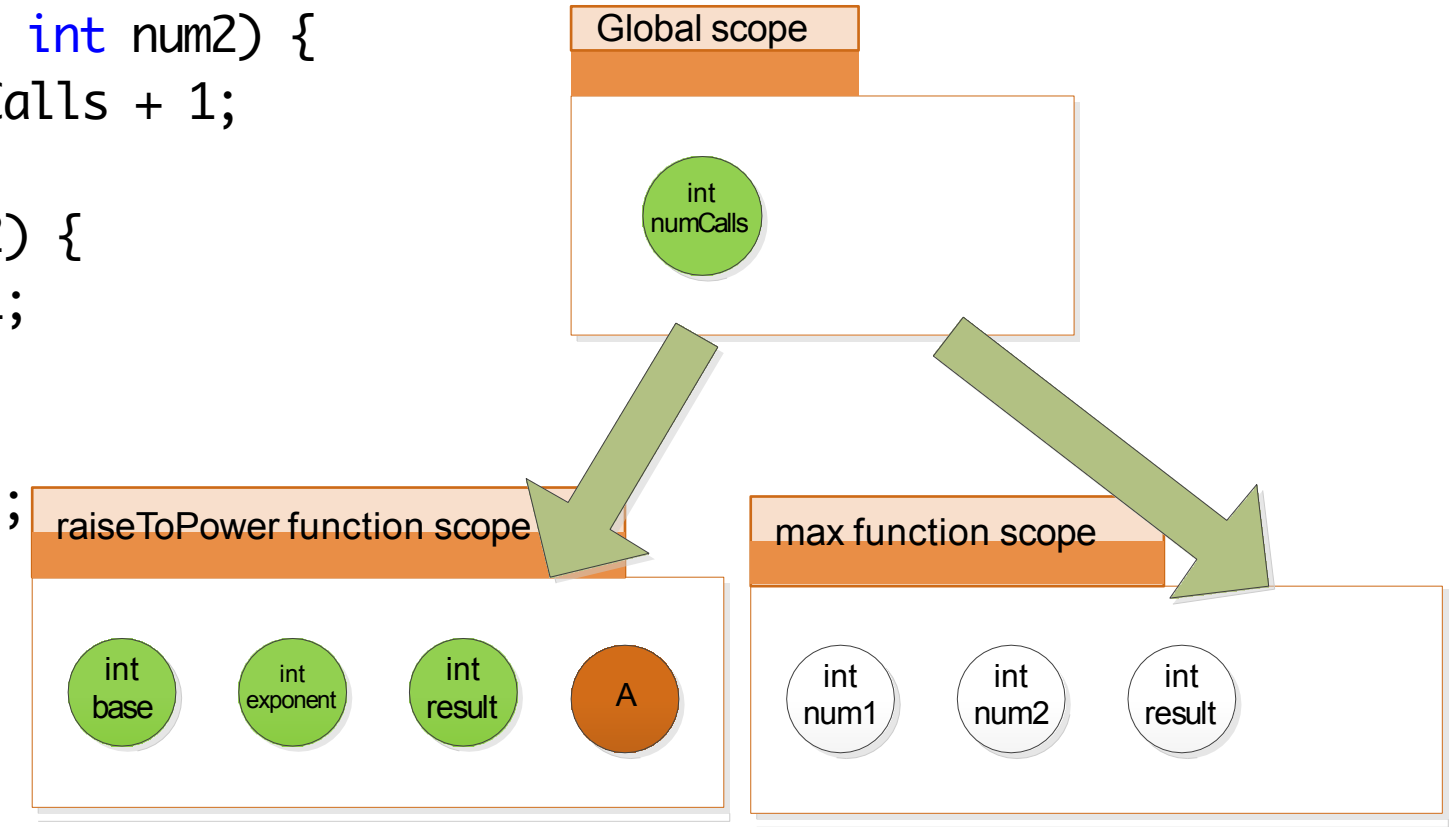
```
int numCalls = 0;
int raiseToPower(int base, int exponent) {
        numCalls = numCalls + 1;
        int result = 1;
        for(int i = 0; i < exponent; i = i +1)
        {
            result= result * base;
        }
        return result;
}

int max(int num1, int num2)
{ numCalls = numCalls + 1;
  int result;
  if(num1> num2)
     result = num1;
  else
     result = num2;
  return result;
}
```

```
int numCalls = 0;
int raiseToPower(int base, int exponent)
  { numCalls = numCalls + 1;
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1) {
    result = result * base;
  }
  // A
  return result;
}int max(int num1, int num2) {
   numCalls = numCalls + 1;
   int result;
   if (num1 > num2) {
     result = num1;
   }
   else {
     result = num2;
   }
   // B
   return result;
}
```



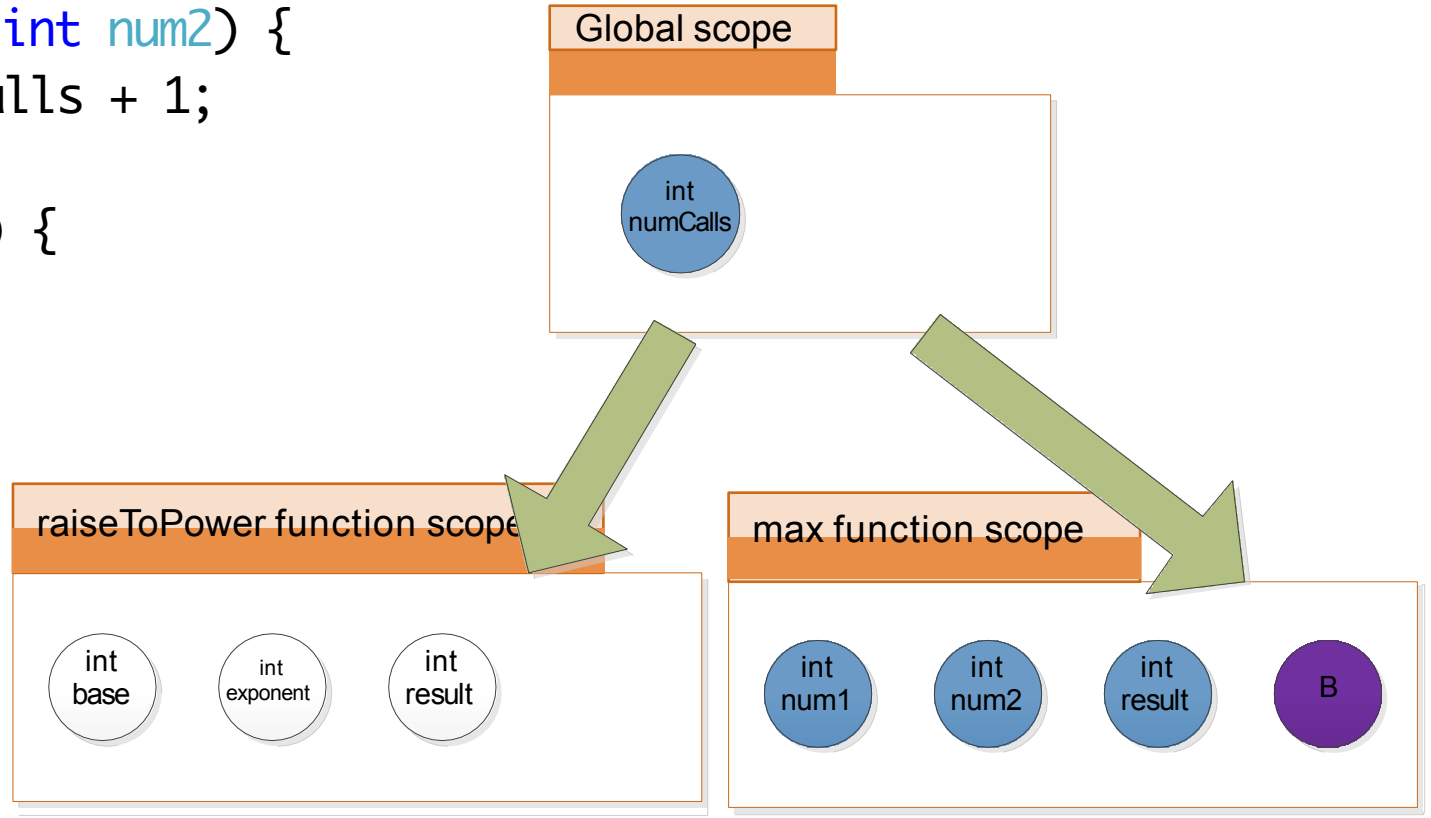
```
int numCalls = 0;
int raiseToPower(int base, int exponent) {
  numCalls = numCalls + 1;
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1) {
    result = result * base;
  }// A
  return result;
}
int max(int num1, int num2) {
  numCalls = numCalls + 1;
  int result;
  if (num1 > num2) {
    result = num1;
  }
  else {
    result = num2;
  }
  // B
  return result;
}
```

- At A, variables marked in green are in scope



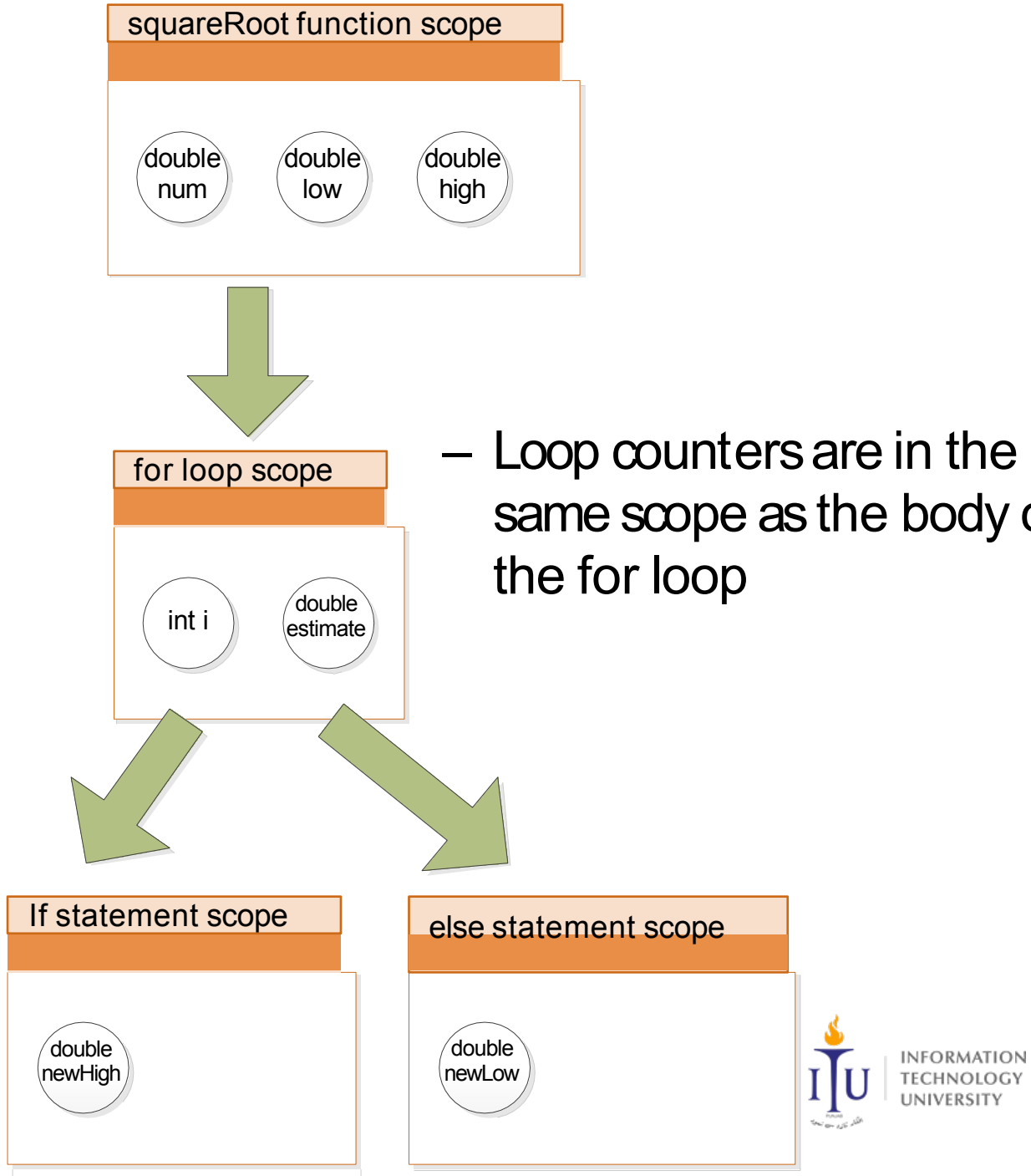
```
int numCalls = 0;
int raiseToPower(int base, int exponent) {
  numCalls = numCalls + 1;
  int result = 1;
  for (int i = 0; i < exponent; i = i + 1) {
    result = result * base;
  }// A
  return result;
}
int max(int num1, int num2) {
  numCalls = numCalls + 1;
  int result;
  if (num1 > num2) {
    result = num1;
  }
  else {
    result = num2;
  }
  // B
  return result;
}
```

- At B, variables marked in blue are in scope



```
double squareRoot(double num) {
  double low = 1.0;
  double high = num;
  for (int i = 0; i < 30; i = i + 1) {
    double estimate = (high + low) / 2;
    if (estimate*estimate > num) {
      double newHigh = estimate;
      high = newHigh;
    } else {
      double newLow = estimate;
      low = newLow;
    }
  }
  return (high + low) / 2;
}
```

- Loops and if/else statements also have their own scopes



– Loop counters are in the same scope as the body of the for loop