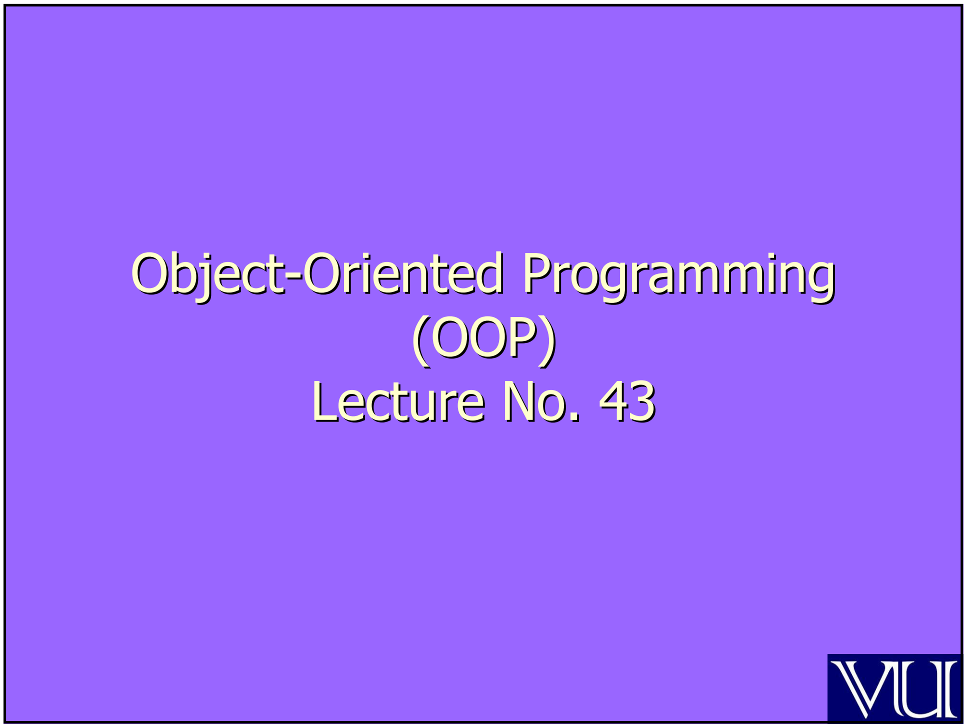
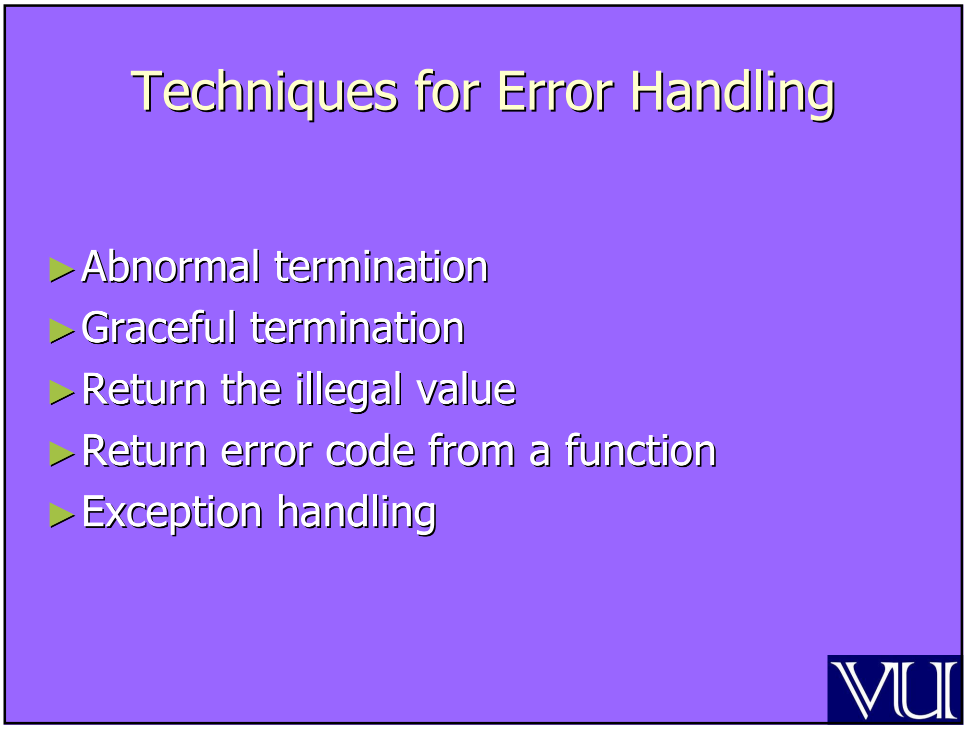


Object-Oriented Programming (OOP)
Lecture No. 43



Techniques for Error Handling

- Abnormal termination
- Graceful termination
- Return the illegal value
- Return error code from a function
- Exception handling

Example – Abnormal Termination

```
void GetNumbers( int &a, int &b ) {
        cout << “\nEnter two integers”;
        cin >> a >> b;
}
int Quotient( int a, int b ){
        return a / b;
}
void OutputQuotient( int a, int b, int quo ) {
        cout << “Quotient of ” << a << “ and ”
                << b << “ is ” << quo << endl;
}
```

Example – Abnormal Termination

```
int main(){
        int sum = 0, quot;
        int a, b;
        for (int i = 0; i < 10; i++){
                GetNumbers(a,b);
                quot = Quotient(a,b);
                sum += quot;
                OutputQuotient(a,b,quot);
        }
        cout << “\nSum of ten quotients is ”<< sum;
        return 0;
}
```

Output

```
Enter two integers
10
10
Quotient of 10 and 10 is 1
Enter two integers
10
0
```

Program terminated abnormally

Graceful Termination

- Program can be designed in such a way that instead of abnormal termination, that causes the wastage of resources, program performs clean up tasks

Example – Graceful Termination

```
int Quotient (int a, int b ) {
        if(b == 0){
                cout << “Denominator can’t “
        << “ be zero” << endl;
                // Do local clean up
                exit(1);
        }
        return a / b;
}
```

Output

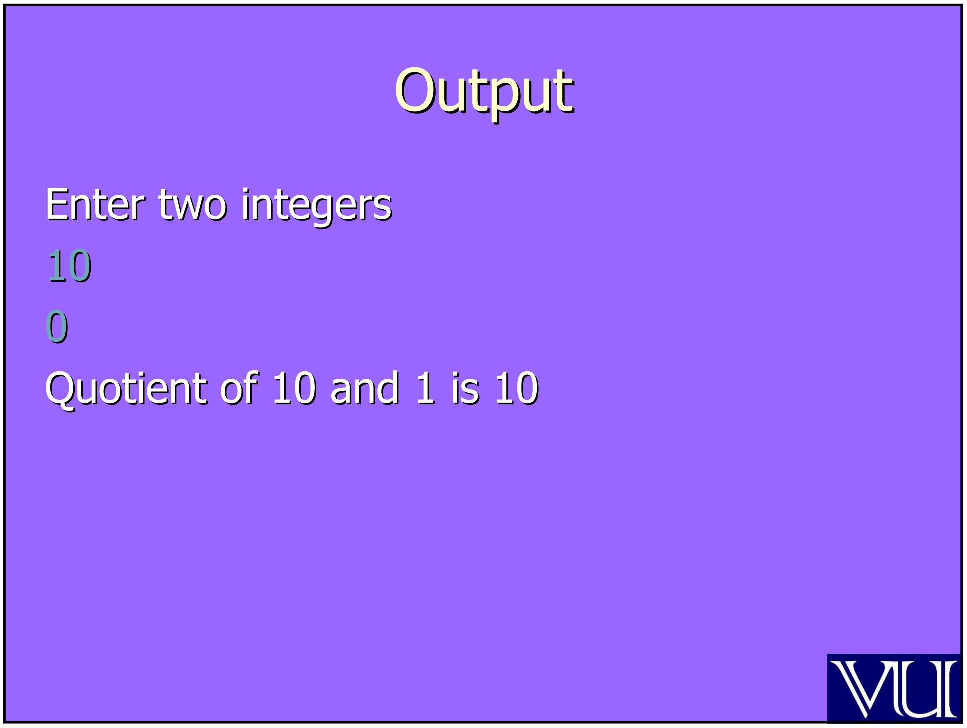
```
Enter two integers
10
10
Quotient of 10 and 10 is 1
Enter two integers
10
0
Denominator can’t be zero
```

Error Handling

- The clean-up tasks are of local nature only
- There remains the possibility of information loss

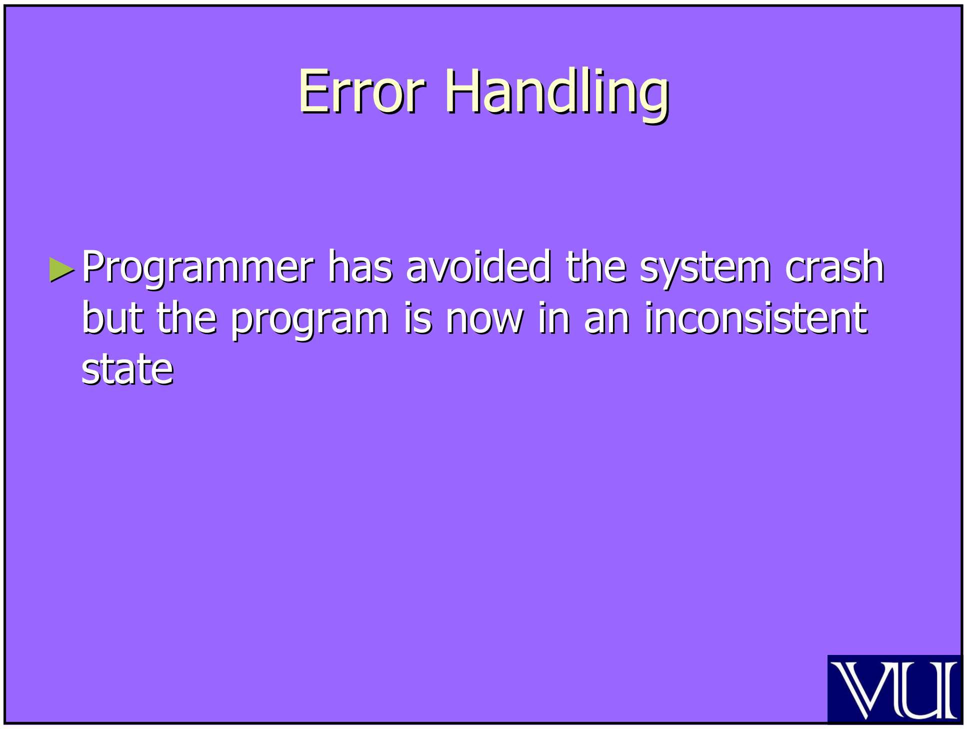
Example – Return Illegal Value

```
int Quotient(int a, int b){
            if(b == 0)
                        b = 1;
            OutputQuotient(a, b, a/b);
            return a / b ;
}
int main() {
            int a,b,quot;      GetNumbers(a,b);
            quot = Quotient(a,b);
            return 0;
}
```



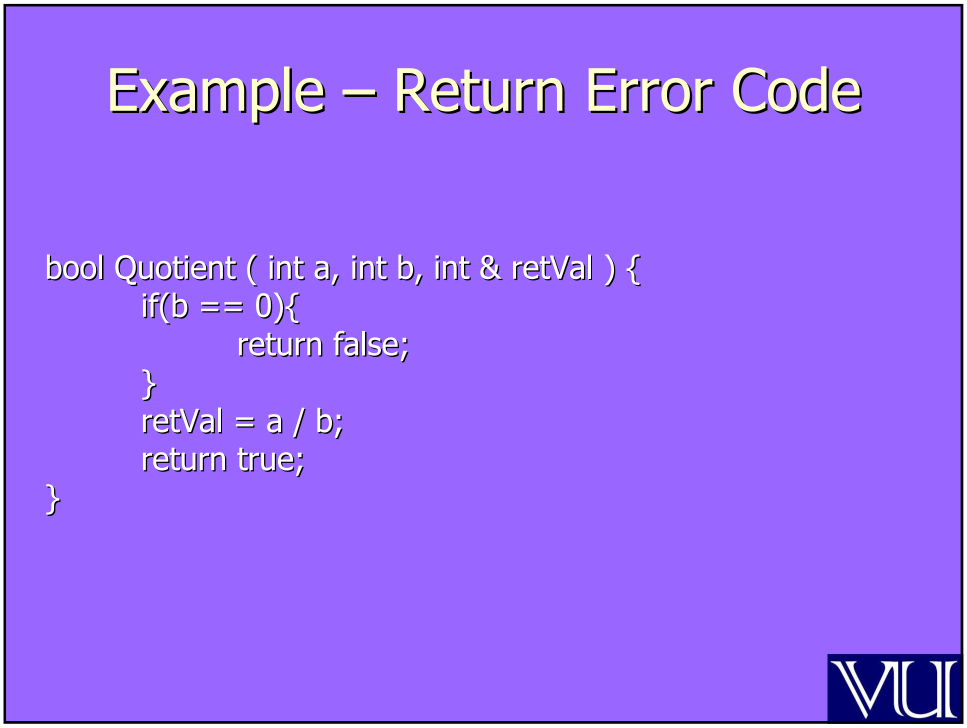
Output

```
Enter two integers
10
0
Quotient of 10 and 1 is 10
```



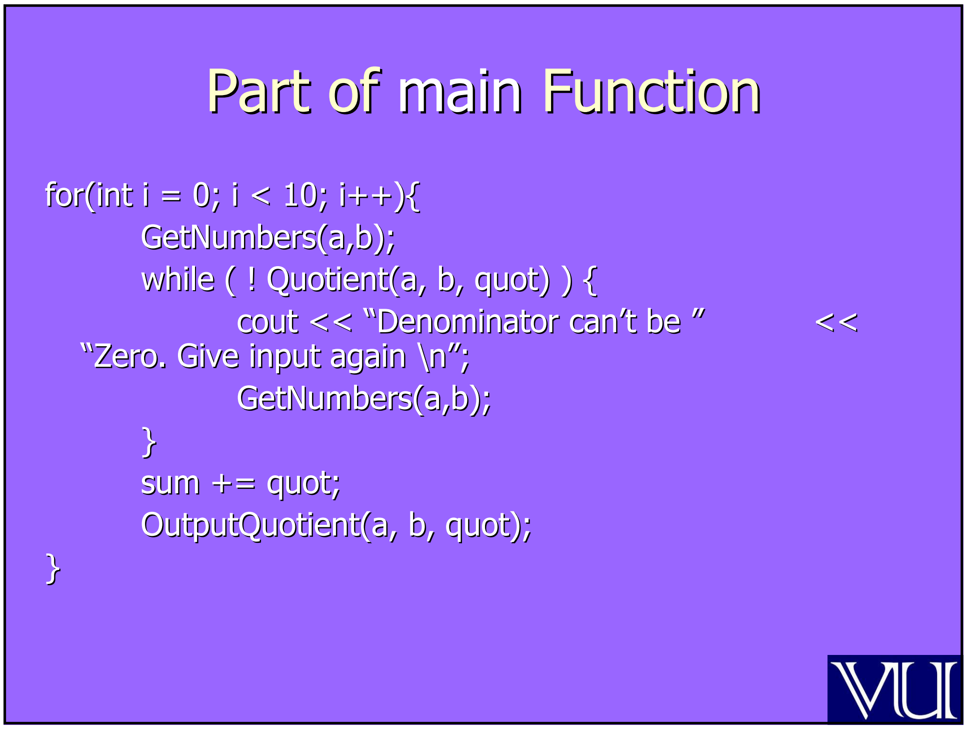
Error Handling

- Programmer has avoided the system crash but the program is now in an inconsistent state



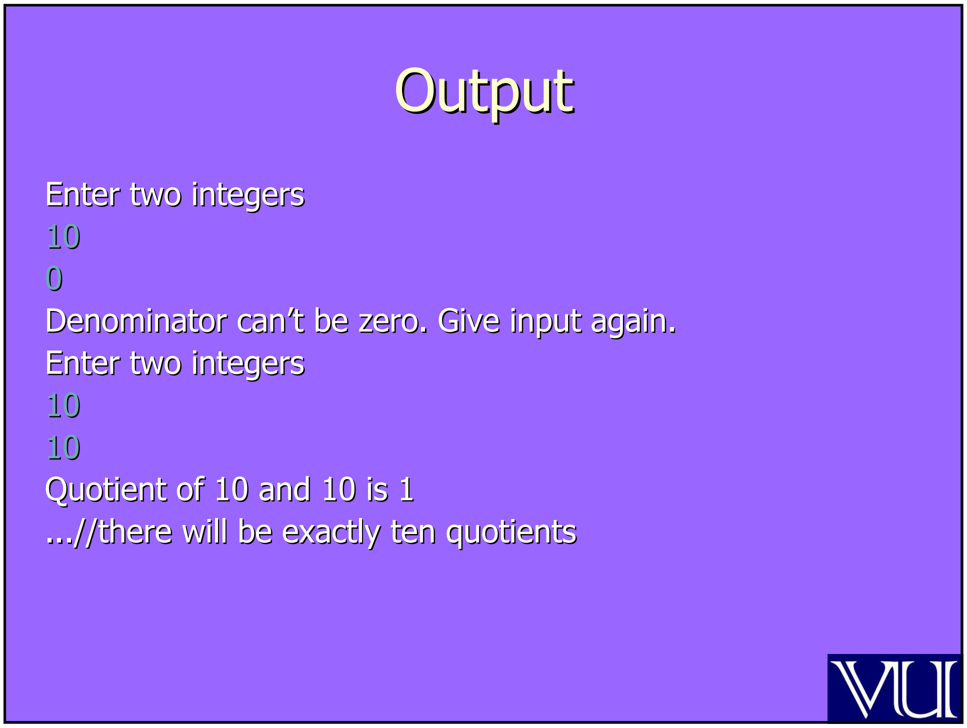
Example – Return Error Code

```
bool Quotient ( int a, int b, int & retVal ) {
        if(b == 0){
                return false;
        }
        retVal = a / b;
        return true;
}
```



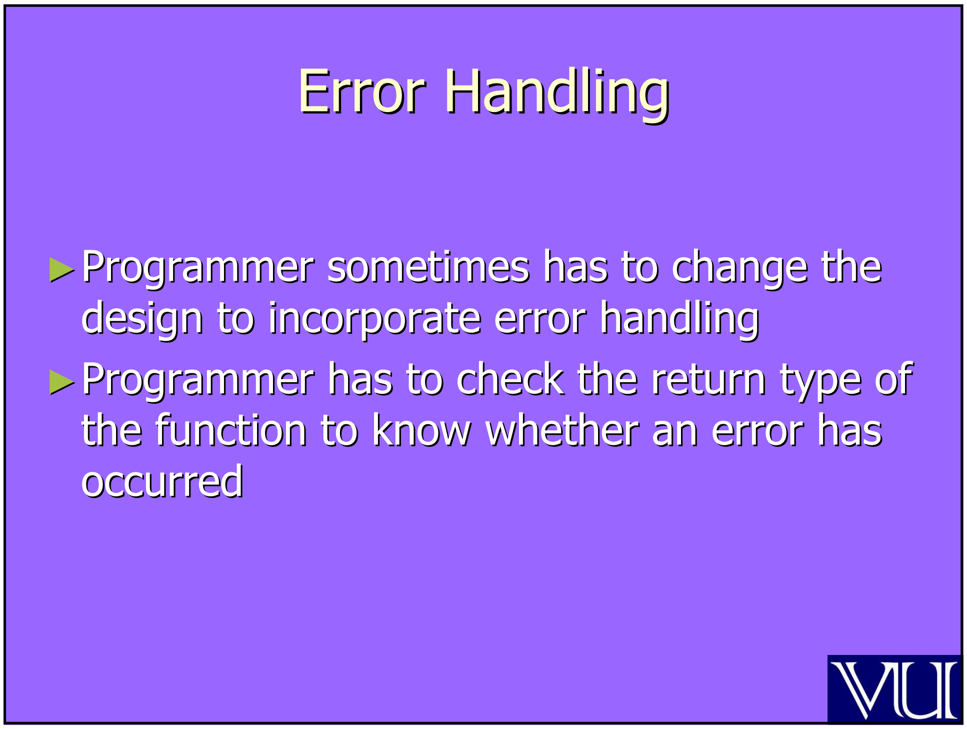
Part of main Function

```
for(int i = 0; i < 10; i++){
        GetNumbers(a,b);
        while ( ! Quotient(a, b, quot) ) {
                cout << “Denominator can’t be ”          <<
   “Zero. Give input again \n”;
                GetNumbers(a,b);
        }
        sum += quot;
        OutputQuotient(a, b, quot);
}
```



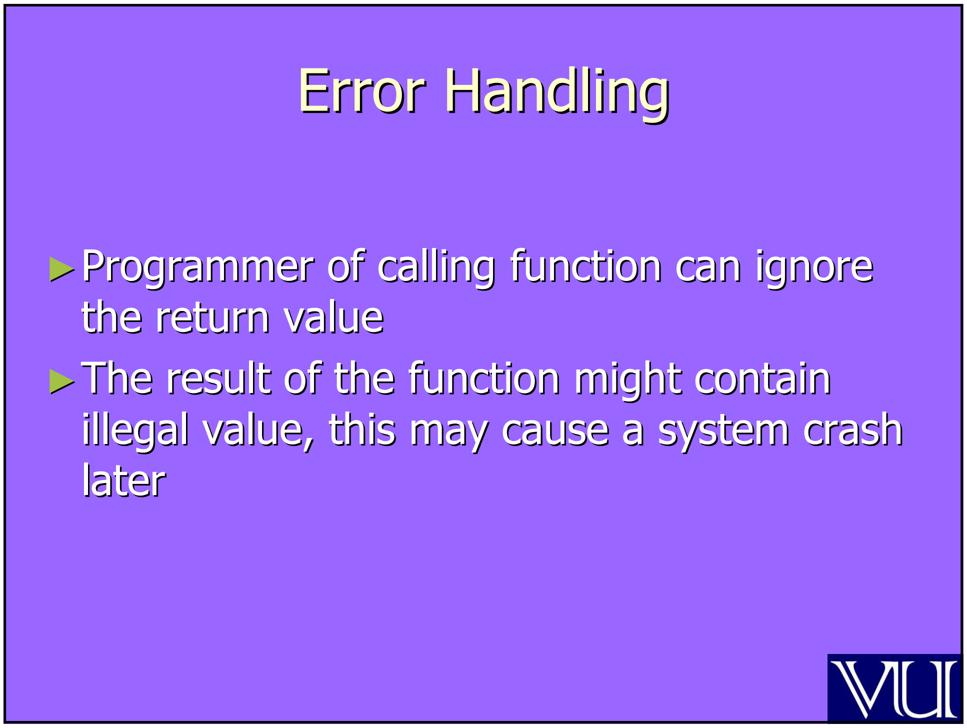
Output

```
Enter two integers
10
0
Denominator can’t be zero. Give input again.
Enter two integers
10
10
Quotient of 10 and 10 is 1
...//there will be exactly ten quotients
```



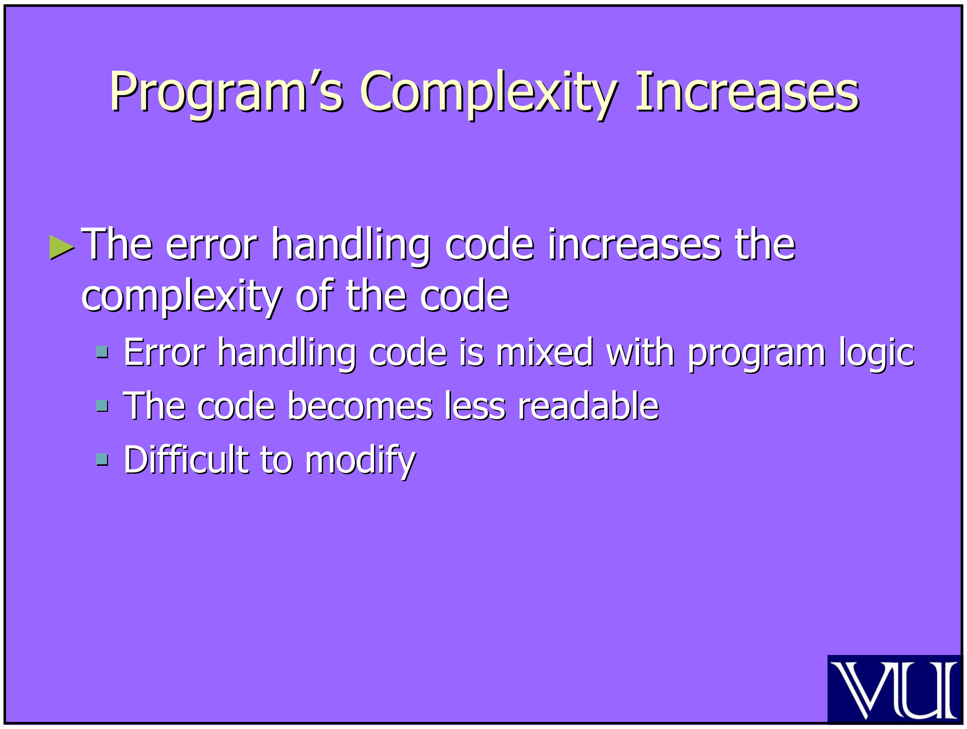
Error Handling

- Programmer sometimes has to change the design to incorporate error handling
- Programmer has to check the return type of the function to know whether an error has occurred



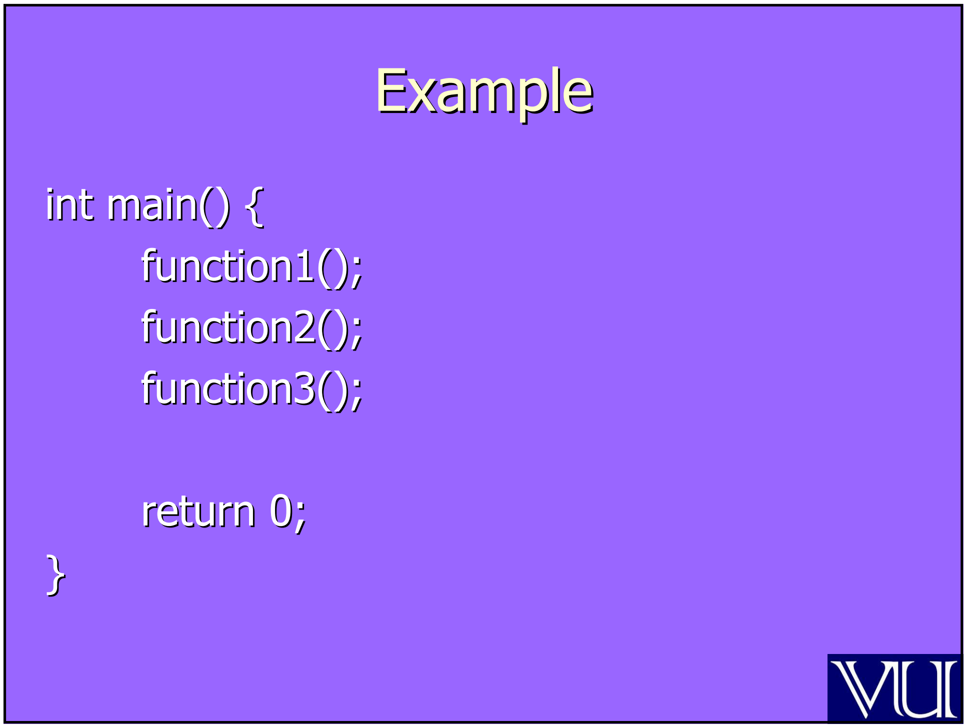
Error Handling

- Programmer of calling function can ignore the return value
- The result of the function might contain illegal value, this may cause a system crash later



Program's Complexity Increases

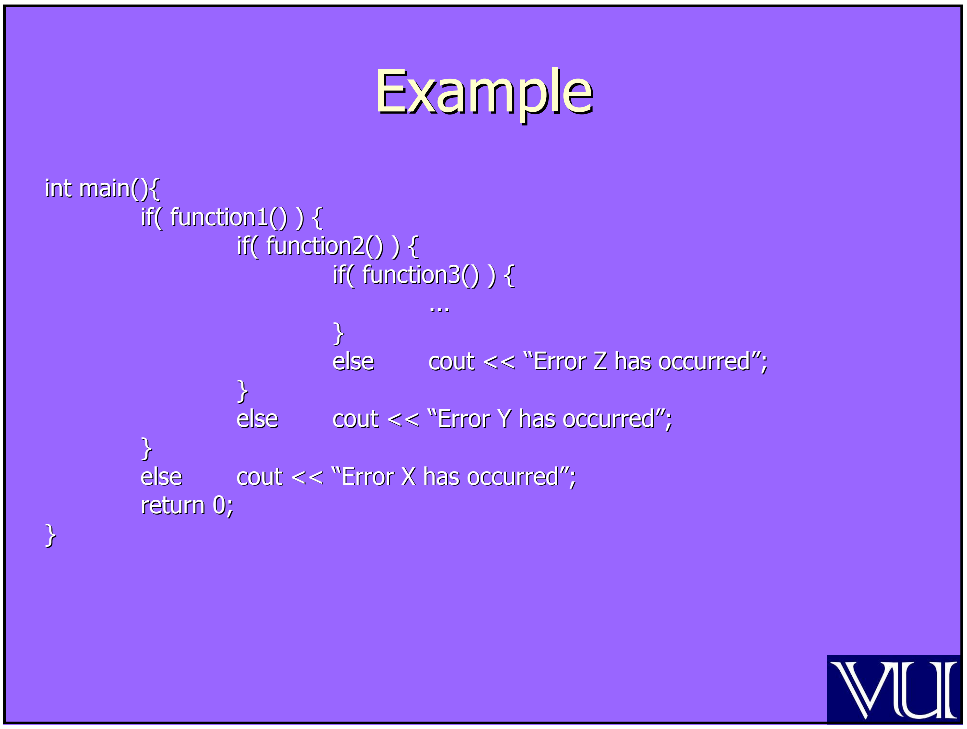
- The error handling code increases the complexity of the code
  - Error handling code is mixed with program logic
  - The code becomes less readable
  - Difficult to modify



Example

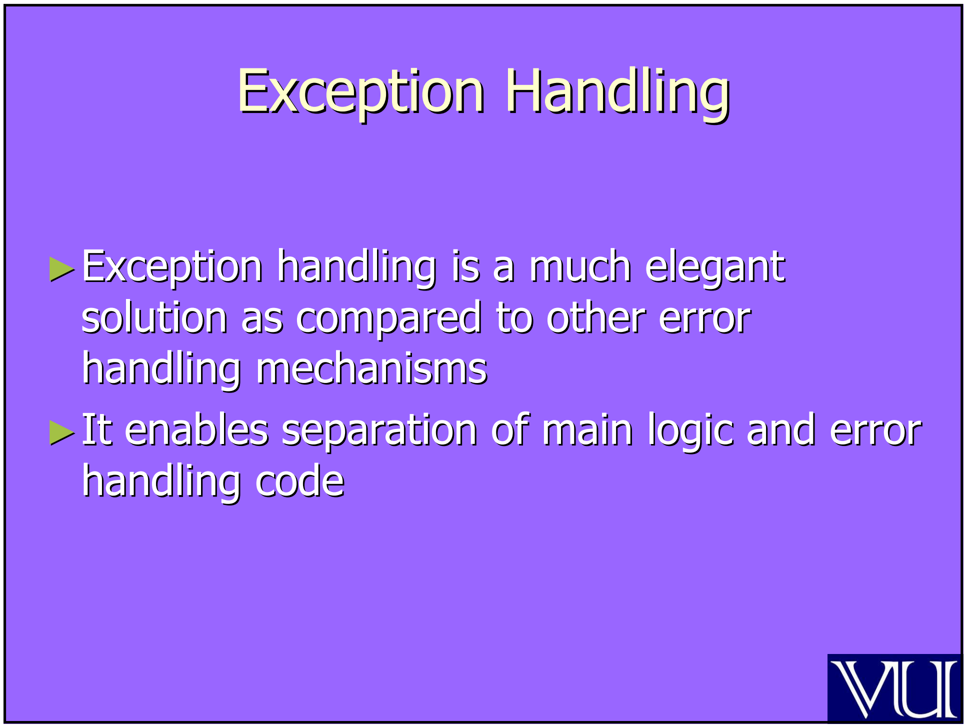
```
int main() {
        function1();
        function2();
        function3();

        return 0;
}
```



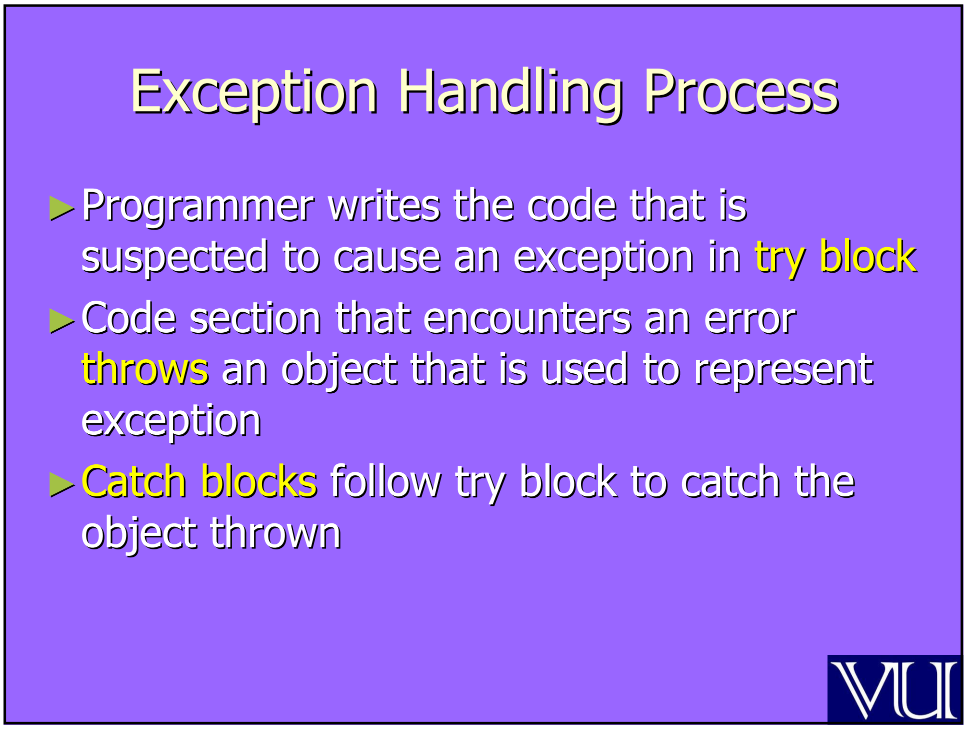
Example

```
int main(){
        if( function1() ) {
                if( function2() ) {
                        if( function3() ) {
                                ...
                        }
                        else    cout << “Error Z has occurred”;
                }
                else    cout << “Error Y has occurred”;
        }
        else    cout << “Error X has occurred”;
        return 0;
}
```



Exception Handling

- Exception handling is a much elegant solution as compared to other error handling mechanisms
- It enables separation of main logic and error handling code



Exception Handling Process

- Programmer writes the code that is suspected to cause an exception in try block
- Code section that encounters an error throws an object that is used to represent exception
- Catch blocks follow try block to catch the object thrown

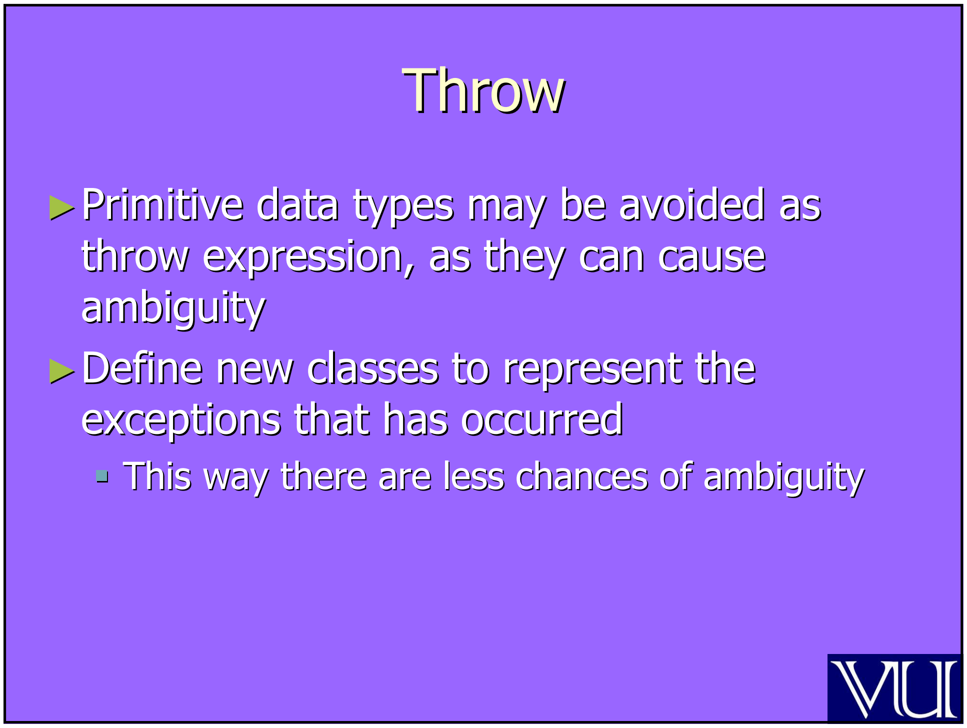
Syntax - Throw

- The keyword throw is used to throw an exception
- Any expression can be used to represent the exception that has occurred

```
throw X;
throw (X);
```

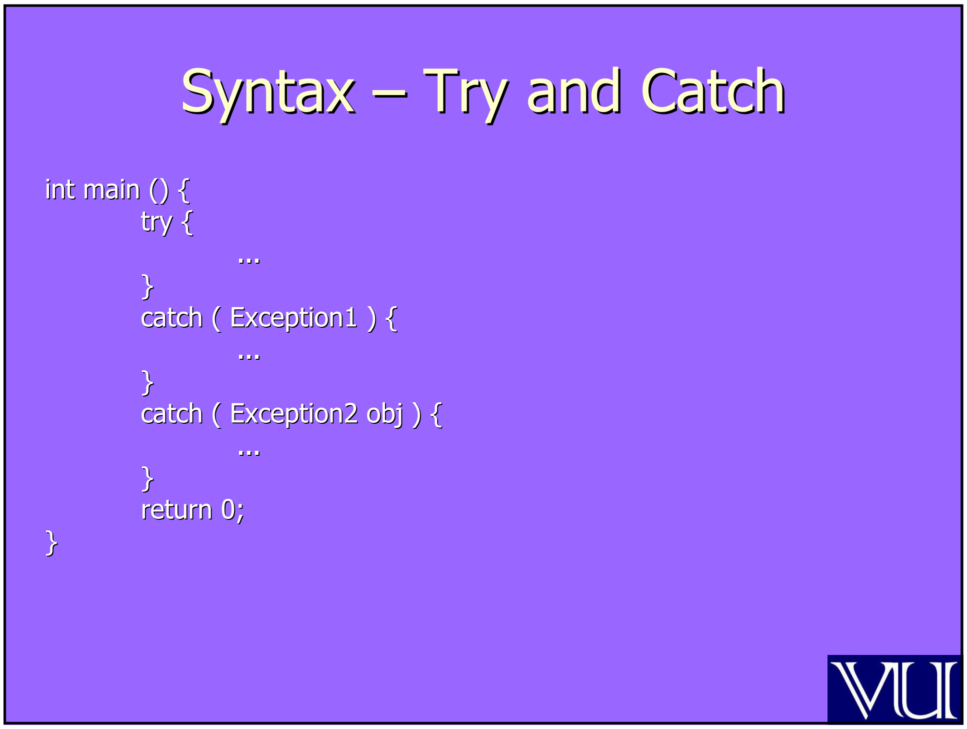
Examples

```
int a;
Exception obj;
throw 1;          // literal
throw (a);                  // variable
throw obj;                  // object
throw Exception();
                // anonymous  object
throw 1+2*9;
                // mathematical expression
```



Throw

- Primitive data types may be avoided as throw expression, as they can cause ambiguity
- Define new classes to represent the exceptions that has occurred
  - This way there are less chances of ambiguity



Syntax – Try and Catch

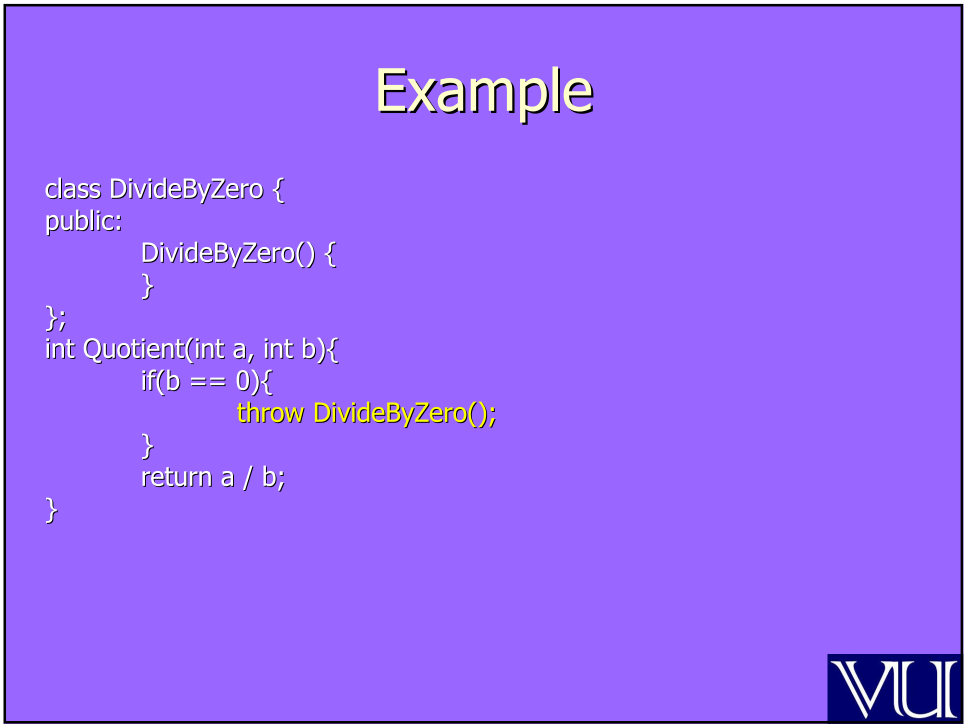
```
int main () {
        try {
                …
        }
        catch ( Exception1 ) {
                …
        }
        catch ( Exception2 obj ) {
                …
        }
        return 0;
}
```

Catch Blocks

- Catch handler must be preceded by a try block or an other catch handler
- Catch handlers are only executed when an exception has occurred
- Catch handlers are differentiated on the basis of argument type

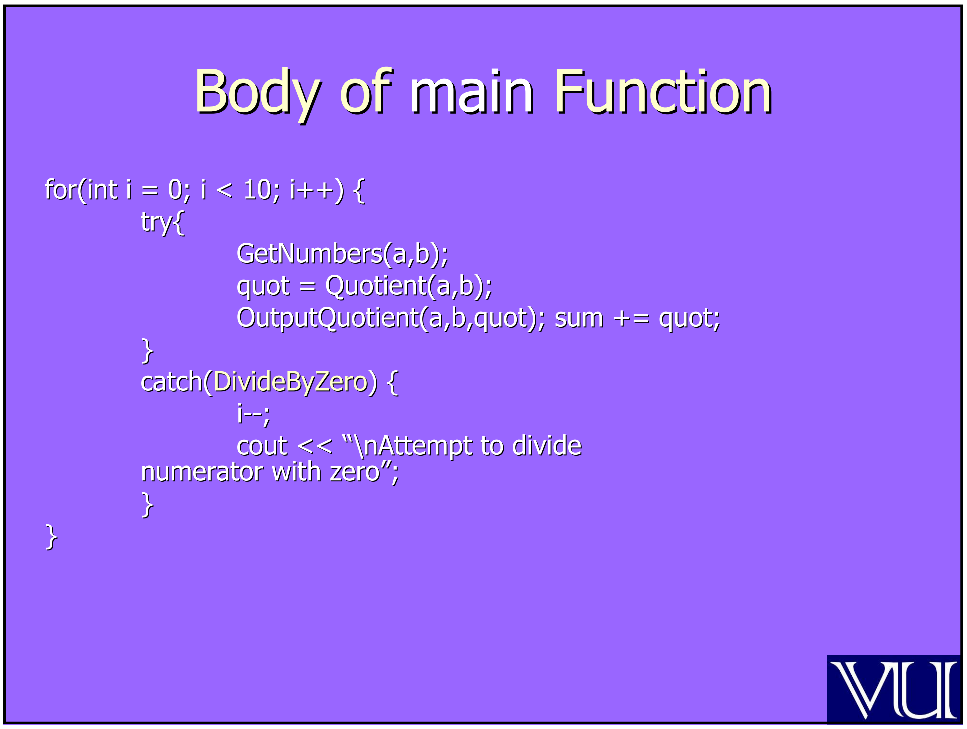
Catch Handler

- The catch blocks are tried in order they are written
- They can be seen as switch statement that do not need break keyword



Example

```
class DivideByZero {
public:
        DivideByZero() {
        }
};
int Quotient(int a, int b){
        if(b == 0){
                throw DivideByZero();
        }
        return a / b;
}
```



Body of main Function

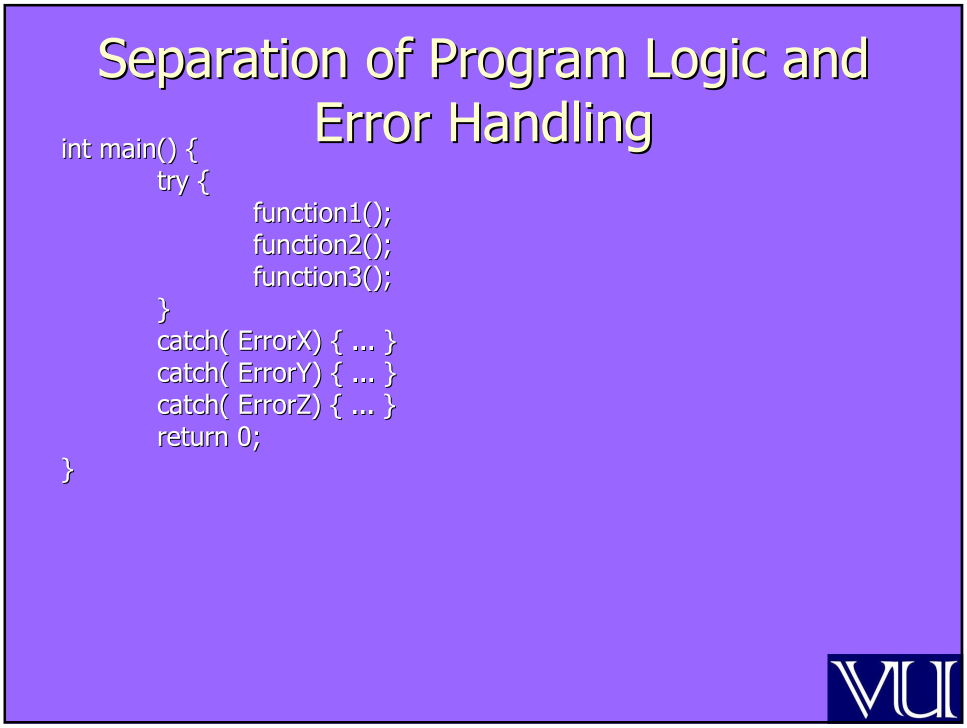
```
for(int i = 0; i < 10; i++) {
        try{
                GetNumbers(a,b);
                quot = Quotient(a,b);
                OutputQuotient(a,b,quot); sum += quot;
        }
        catch(DivideByZero) {
                i--;
                cout << "\nAttempt to divide
        numerator with zero";
        }
}
```

Output

```
Enter two integers
10
10
Quotient of 10 and 10 is 1
Enter two integers
10
0
Attempt to divide numerator with zero
...
// there will be sum of exactly ten quotients
```

Catch Handler

- The catch handler catches the DivideByZero object through anonymous object
- Program logic and error handling code are separated
- We can modify this to use the object to carry information about the cause of error



Separation of Program Logic and Error Handling

```
int main() {
        try {
                function1();
                function2();
                function3();
        }
        catch( ErrorX) { ... }
        catch( ErrorY) { ... }
        catch( ErrorZ) { ... }
        return 0;
}
```