Slides

Development > Programming Languages > C++

The C++ 20 Masterclass : From Fundamentals to Advanced

Learn and Master Modern C++ From Beginning to Advanced in Plain English : C++11, C++14, C++17, C++20 and More!

4.7 ★★★★☆

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Section : Exceptions

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Exception handling : Introduction

A C++ built in mechanism to bring problems to the surface and possibly handle them

- static_assert
- assert
- std::cout

```
try{

        throw 0;

}catch(int ex){

}
```

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try and catch blocks

Syntax

```
int a{10};
int b{0};

try{
    Item item; // When exception is thrown, control immediately exits the try block
               // an automatic local variables are released
               // But pointers may leak memory.
    if( b == 0 )
        throw 0;
    a++; // Just using a and b in here, could use them to do anything.
    b++;
    std::cout << "Code that executes when things are fine" << std::endl;

}catch(int ex){
    std::cout << "Something went wrong. Exception thrown : " << ex <<  std::endl;
}

std::cout << "END." << std::endl;
```

Throwing pointers to locals : BAD!

```
int c{0};
try{
    int var{55};
    int* int_ptr = &var;
    if(c == 0)
        throw int_ptr;
    std::cout << "Keeping doing some other things..." << std::endl;
}catch(int* ex){
    std::cout << "Something went wrong. Exception thrown : " <<*ex << std::endl;
}
std::cout << "END." << std::endl;
```

Pointers in try block : LEAKS!

```
int d{0};
try{
    Item * item_ptr = new Item();
    if(d == 0)
        throw 0;
    std::cout << "Keeping doing some other things..." << std::endl;
}catch(int ex){
    std::cout << "Something went wrong. Exception thrown : "<< ex << std::endl;
}
std::cout << "END." << std::endl;
```

Unhandled exceptions : CRASH!

```
//If you throw an exception and it's not handled anywhere in your code,
//you'll get a hard crash

throw 0;
std::cout << "Doing something after we throw" << std::endl;

std::cout << "END." << std::endl;
```

Thrown objects must be copyable

```
// If copy constructor is either deleted, protected or private, the
// object can't be thrown as exception. You'll get a compiler error.

try{
    MyException e;
    throw e; //

}catch(MyException ex){

}
std::cout << "END." << std::endl;
```

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The need for exceptions

Integer division by 0

```
//int division by 0 : CRASH

const int a{45};
const int b{0};
int result = a/b;
```

Failing downcast

```
//Downcast using dynamic_cast with references
//The hierarchy of Animal->Dog has to be polymorphic to be able to do
//this. This throws an exception because animal has no dog part so the
//cast won't really work.

Animal a;
Dog& d{dynamic_cast<Dog&>(a)};
```

Recovering from integer division by zero

```
//Integer division
const int a{45};
const int b{0};
int result;

try{
    if(b == 0)
        throw 0;
   result = a/b;
}
catch(int ex){
    std::cout << "Integer division by zero detected" << std::endl;
}
std::cout<< "END." << std::endl;
```

Thrown type must the same as the catch parameter

```
//Integer division
const int a{45};
const int b{0};
int result;

try{
    if(b == 0)
        throw 0;
   result = a/b;
}
catch(std::string ex){
    std::cout << "Integer division by zero detected" << std::endl;
}

std::cout<< "END." << std::endl;
```

Thrown type must the same as the catch parameter

```
//Integer division
const int a{45};
const int b{0};
int result;

try{
    if(b == 0)
        throw 0;
   result = a/b;
}
catch(std::string ex){
    std::cout << "Integer division by zero detected" << std::endl;
}
catch(int ex){
    //Some processing
}

std::cout<< "END." << std::endl;
```

Exceptions thrown in functions

```
/*  Function throws const char* exception when par_b is zero  */
void process_parameters( int par_a , int par_b){

    // Do some processing

    if(par_b == 0)
        throw "Potential division by 0 detected";

    int result = par_a / par_b;

    //Some other processing.
}
```

Handling exceptions thrown in functions

```
//Exceptions thrown out of other parts of code written by you
//or somebody else
try{
    process_parameters(10,0);
}catch(const char* ex){
    std::cout <<"Exception: " <<  ex << std::endl;
}
```

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Handling Exceptions at different levels

Chained calls

```
void f1(){
    std::cout << "Starting f1()" << std::endl;
    f2();
    std::cout << "Ending f1()" << std::endl;
}

void f2(){
    std::cout << "Starting f2()" << std::endl;
    f3();
    std::cout << "Ending f2()" << std::endl;
}

void f3(){
    std::cout << "Starting f3()" << std::endl;
    std::cout << "Ending f3()" << std::endl;
}
```

C:\Windows\SYSTEM32\cmd.exe

```
Starting f1()
Starting f2()
Starting f3()
Ending f3()
Ending f2()
Ending f1()
END.
```

Execution Thrower

```
void exception_thrower(){
    std::cout << "starting execution_thrower()" << std::endl;
    throw 0;// Execution will halt from here
    std::cout << "ending execution_thrower()" << std::endl;
}
```

Exception thrown in f3(). Not handled

```
//Exception thrown from f3() scope : Not handled anywhere
void f1(){
    std::cout << "Starting f1()" << std::endl;
    f2();
    std::cout << "Ending f1()" << std::endl;
}

void f2(){
    std::cout << "Starting f2()" << std::endl;
    f3();
    std::cout << "Ending f2()" << std::endl;
}

void f3(){
    std::cout << "Starting f3()" << std::endl;
    exception_thrower();
    std::cout << "Ending f3()" << std::endl;
}
```

C:\Windows\SYSTEM32\cmd.exe

```
Starting f1()
Starting f2()
Starting f3()
starting execution_thrower()
terminate called after throwing an instance of 'int'
```

Exception thrown in f3(). Handled in f3()

```
void f1(){
    std::cout << "Starting f1()" << std::endl;
    f2();
    std::cout << "Ending f1()" << std::endl;
}

void f2(){
    std::cout << "Starting f2()" << std::endl;
    f3();
    std::cout << "Ending f2()" << std::endl;
}

void f3(){
    std::cout << "Starting f3()" << std::endl;
    try{
        exception_thrower();
    }catch(int ex){
        std::cout << "Handling execution in f3()" << std::endl;
    }
    std::cout << "Ending f3()" << std::endl;
}
```

C:\Windows\SYSTEM32\cmd.exe

```
Starting f1()
Starting f2()
Starting f3()
starting execution_thrower()
Handling execution in f3()
Ending f3()
Ending f2()
Ending f1()
END.
```

Exception thrown in f3(). Handled in f2()

```
void f1(){
    std::cout << "Starting f1()" << std::endl;
    f2();
    std::cout << "Ending f1()" << std::endl;
}

void f2(){
    std::cout << "Starting f2()" << std::endl;
    try{
        f3();
    }catch(int ex){
        std::cout << "Handling execution in f2()" << std::endl;
    }
    std::cout << "Ending f2()" << std::endl;
}

void f3(){
    std::cout << "Starting f3()" << std::endl;
    exception_thrower();
    std::cout << "Ending f3()" << std::endl;
}
```

C:\Windows\SYSTEM32\cmd.exe

```
Starting f1()
Starting f2()
Starting f3()
starting execution_thrower()
Handling execution in f2()
Ending f2()
Ending f1()
END.
```

Exception thrown in f3(). Handled in f1()

```
void f1(){
    std::cout << "Starting f1()" << std::endl;
    try{
        f2();
    }catch(int ex){
        std::cout << "Handling execution in f1()" << std::endl;
    }
    std::cout << "Ending f1()" << std::endl;
}

void f2(){
    std::cout << "Starting f2()" << std::endl;
    f3();
    std::cout << "Ending f2()" << std::endl;
}

void f3(){
    std::cout << "Starting f3()" << std::endl;
    exception_thrower();
    std::cout << "Ending f3()" << std::endl;
}
```

C:\Windows\SYSTEM32\cmd.exe

```
Starting f1()
Starting f2()
Starting f3()
starting execution_thrower()
Handling execution in f1()
Ending f1()
END.
```

Exception thrown in f3(). Handled main()

```
//Exception thrown from f3() scope : Not handled anywhere
void f1(){
    std::cout << "Starting f1()" << std::endl;
    f2();
    std::cout << "Ending f1()" << std::endl;
}

void f2(){
    std::cout << "Starting f2()" << std::endl;
    f3();
    std::cout << "Ending f2()" << std::endl;
}

void f3(){
    std::cout << "Starting f3()" << std::endl;
    exception_thrower();
    std::cout << "Ending f3()" << std::endl;
}
```

Handling the exception in main()

```
int main(int argc, char **argv)
{
    try{
        f1();
    }catch(int ex){
        std::cout << "Handling execution in main()" << std::endl;
    }

    std::cout << "END." << std::endl;
    return 0;
}
```

C:\Windows\SYSTEM32\cmd.exe

```
Starting f1()
Starting f2()
Starting f3()
starting execution_thrower()
Handling execution in main()
END.
```

Facts

- You can choose to handle the exceptions at a level in your function call chain that makes sense for your application
- In the extreme case, you can handle all your exceptions in main by just wrapping all the code in a try block and following it with an appropriate series of catch blocks
- The further you choose to handle your exception from where it was thrown, the more you risk for functions to not terminate normally
- Functions that don't terminate normally are bad : they may leak memory or just not completely do what they were designed to do.

Guideline

- If you know (from the documentation or code) that the function you're about to call may throw an exception, you should wrap that call in a try block and handle the exception appropriately, that way your function doesn't run the risk of non terminating properly when an the exception is thrown.

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Multiple handlers for an exception

```
void f1(){
    std::cout << "Starting f1()" << std::endl;
    try{
        f2();
    }catch(int ex){
        std::cout << "Exception handled in f1()" << std::endl;
    }
    std::cout << "Ending f1()" << std::endl;
}
```

```
void f2(){
    std::cout << "Starting f2()" << std::endl;
    try{
        f3();
    }catch(int ex){
        std::cout << "Exception handled in f2()" << std::endl;
    }
    std::cout << "Ending f2()" << std::endl;
}
```

```
void f3(){
    std::cout << "Starting f3()" << std::endl;
    try{
        exception_thrower();
    }catch(int ex){
        std::cout << "Exception handled in f3()" << std::endl;
    }
    std::cout << "Ending f3()" << std::endl;
}
```

```
int main(int argc, char **argv)
{
    try{
        f1();
    }catch(int ex){
        std::cout << "Handling execution in main()" << std::endl;
    }
    std::cout << "main() finishing up" << std::endl;
    return 0;
}
```

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Nested try blocks

```
void some_function(){
    for(size_t i{} ; i < 15 ;++i){
        std::cout << "Iteration : " << i << std::endl;

        try{ // Outer try block
            //Exceptions thrown in this scope are
            //handled in outer catch blocks
            if(i ==2 ){
                throw "exception for int 2 thrown" ;// Throws const char*
            }

            try{ // Inner try block ...

        }
        catch(const char* ex){
            std::cout<< "Outer catch(const char*) block , cought  :" << ex  << std::endl;
        }
        catch(size_t ex){
            std::cout << "Outer catch(size_t) block, cought " << ex << std::endl;
        }
    }
}
```

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Throwing class objects

```
class SomethingIsWrong{
public :
    SomethingIsWrong(const std::string s)
        : m_message(s)
        {
        }

    //Copy Constructor
    SomethingIsWrong(const SomethingIsWrong& source){

    //Destructor
    ~SomethingIsWrong(){
        std::cout << "SomethingIsWrong destructor called" << std::endl;
    }
    std::string_view what()const{
        return m_message;
    }
private :
    std::string m_message;
};
```

```
void do_something(size_t i){
      if(i == 2){
          throw SomethingIsWrong("i is 2");
      }
      std::cout << "Doing something at iteration : " << i << std::endl;
}

int main(int argc, char **argv)
{
    for(size_t i{0}; i < 5 ; ++i){

      try{
          do_something(i);
      }
      catch(SomethingIsWrong& ex){
          std::cout << "Exception cought : " << ex.what() << std::endl;
      }
    }

    return 0;
}
```

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Exceptions as class objects & Inheritance hierarchies

```
class SomethingIsWrong{
public :
    SomethingIsWrong(const std::string& s) : m_message(s){}
     ~SomethingIsWrong(){}
     const std::string& what()const{return m_message;}
protected :
    std::string m_message;
};

class Warning : public SomethingIsWrong{
    public :
    Warning(const std::string& s) : SomethingIsWrong(s){}
};

class SmallError : public Warning{
    public :
    SmallError(const std::string& s) : Warning(s){}
};

class CriticalError : public SmallError{
    public :
    CriticalError(const std::string& s) : SmallError(s){}
};
```

```
void do_something(size_t i){
      if(i == 2){
          throw CriticalError("i is 2");
      }

      if(i == 3){
          throw SmallError("i is 3");
      }
      std::cout << "Doing something at iteration : " << i << std::endl;
}
```

```
int main(int argc, char **argv)
{
    for(size_t i{0}; i < 5 ; ++i){

      try{
          do_something(i);
      }
      catch(CriticalError& ex){
          std::cout << "CriticalError Exception cought : " << ex.what() << std::endl;
      }
      catch(SmallError& ex){
          std::cout << "SmallError Exception cought : " << ex.what() << std::endl;
      }
      catch(Warning& ex){
          std::cout << "Warning Exception cought : " << ex.what() << std::endl;
      }
      catch(SomethingIsWrong& ex){
          std::cout << "SomethingIsWrong Exception cought : " << ex.what() << std::endl;
      }
    }
    return 0;
}
```

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Polymorphic Exceptions

```
class SomethingIsWrong{
public :
    SomethingIsWrong(const std::string& s) : m_message(s){}
    virtual ~SomethingIsWrong(){}
    virtual const std::string& what()const{return m_message;}
protected :
    std::string m_message;
};

class Warning : public SomethingIsWrong{
    public :
    Warning(const std::string& s) : SomethingIsWrong(s){}
};

class SmallError : public Warning{
    public :
    SmallError(const std::string& s) : Warning(s){}
};

class CriticalError : public SmallError{
    public :
    CriticalError(const std::string& s) : SmallError(s){}
};
```

```
void do_something(size_t i){
      if(i == 2){
          throw CriticalError("i is 2");
      }

      if(i == 3){
          throw SmallError("i is 3");
      }
      std::cout << "Doing something at iteration : " << i << std::endl;
}
```

```
int main(int argc, char **argv)
{
    std::cout << "Object Exceptions with Class Inheritance Hierarchies" << std::endl;

    for(size_t i{0}; i < 5 ; ++i){

      try{
          do_something(i);
      }

      catch(SomethingIsWrong& ex){
          std::cout << "SomethingIsWrong Exception cought : " << ex.what() << std::endl;

          //Using typeid()
          //std::cout << typeid(ex).name()  << "Exception cought : " << ex.what() << std::endl;
      }
    }
    return 0;
}
```

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Rethrown exceptions

```
class SomethingIsWrong{
public :
    SomethingIsWrong(const std::string& s) : m_message(s){}
    virtual ~SomethingIsWrong(){}
    virtual const std::string& what()const{return m_message;}
    void set_message(const std::string& m) {m_message = m;}
protected :
    std::string m_message;
};

class Warning : public SomethingIsWrong{
    public :
    Warning(const std::string& s = "Warning Object") : SomethingIsWrong(s){}
};

class SmallError : public Warning{
    public :
    SmallError(const std::string& s = "SmallError object") : Warning(s){}
};

class CriticalError : public SmallError{
    public :
    CriticalError(const std::string& s = "CriticalError object" ) : SmallError(s){}
};
```

```
void do_something(size_t i){
    Warning w;
    SmallError s_e;
    CriticalError c_e;

    if(i == 1){
        w.set_message("Warning Object for iteration : 1 ");
        throw w;
    }

    if(i == 2){
        s_e.set_message("SmallError Object for iteration :  2 ");
        throw s_e;
    }

    if(i == 3){
        c_e.set_message("CriticalError Object for iteration :  3 ");
        throw c_e;
    }

      std::cout << "Doing something at iteration : " << i << std::endl;
}
```

```
for(size_t i{0}; i < 5 ; ++i){
    try{
        try{
            do_something(i);
        }
        catch(SomethingIsWrong& ex_inner){
            if(typeid(ex_inner) == typeid(Warning)){
                std::cout << typeid(ex_inner).name()  <<
                    " -Inner catch block ,Exception cought : " <<
                    ex_inner.what() << std::endl;
            }else{
                throw;
                //throw ex_inner;//This will do a copy, and there will be slicing.Beware.
            }
        }
    }
    catch(SomethingIsWrong& ex_outer){
        std::cout << typeid(ex_outer).name() <<
                " -Outer catch block, Exception cought : " <<
                    ex_outer.what() << std::endl;
    }
}//End of for loop
```

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Program custom termination

```
int main(int argc, char **argv)
{
    throw 1;

    return 0;
}
```

```
C++ is wired this way :
      . if an exception is not handled anywhere in the app,
         the function std::terminate() located in <exception>
          will be called

      . std::terminate will in turn call std::abort() located
          in <cstdlib> to actually kill the program
```

```
void our_terminate_function(){
    std::cout << "Our custom terminate function called" << std::endl;
    std::cout << "Program will terminate in 10s ..." << std::endl;
    //std::this_thread::sleep_for(std::chrono::milliseconds(10000));
    std::abort();
}

int main(int argc, char **argv)
{
    std::set_terminate(&our_terminate_function);
     /*
    std::set_terminate([](){
            std::cout << "Our custom terminate function called" << std::endl;
            std::cout << "Program will terminate in 10s ..." << std::endl;
            std::this_thread::sleep_for(std::chrono::milliseconds(10000));
            std::abort();
    });
    */

    throw 1;

    return 0;
}
```

If you don’t call std::abort() in your terminate function, the system will still kill your application

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Ellipsis catch all block

```
void some_function(size_t i){
    if(i == 0)
        throw 1;
    if(i ==2)
        throw "const char*-Hello there";
    if(i==3)
        throw CriticalError();
    if(i==4)
        throw std::string("std::string-Hello there");
}
```

```
int main(int argc, char **argv)
{
    try{
        for( size_t i{}; i < 5; ++i){
            try{
                some_function(i);
            }
            catch(int ex){
                std::cout << "int handler- Cought an integer" << std::endl;
            }
            catch(...){
                std::cout << "Inner... handler , Cought some exception" << std::endl;
               // throw;
            }
        }
    }
    catch(const std::string& ex){
        std::cout << "Cought some string exception" << std::endl;
    }
    catch(...){
        std::cout << "Outer ...handler cought some other exception" << std::endl;
    }
    return 0;
}
```

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noexcept specifier

noexcept method

```
class Item{
public :
        Item(){}

        void do_something_in_class() const noexcept{
            std::cout << "Doing something from class" << std::endl;
            try{
                throw 1;
            }
            catch(int ex){
                std::cout << "Handling exception in Item::do_something_in_class" << std::endl;
                //throw; // Rethrowing in noexcept function/method will terminate program
            }
        }
private :
        int m_member_var;
};
```

noexcept free function

```
void some_function() noexcept{

    try{
        throw 1;
    }
    catch(int ex){
        std::cout << "Handling int excpetion in free function some_function()" << std::endl;
        throw;
    }

}
```

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Exceptions in destructors

```
class Item{
public :
    Item(){}
    ~Item(){
    throw;
    }
};
```

```
class Item{
public :
    Item(){}
    ~Item() noexcept(false) {

        throw;

    }
};
```

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Standard exceptions

exception

logic_error	runtime_error	others
. invalid_argument . length_error . out_of_range	. overflow_error . underflow_error	. bad_alloc . bad_cast

std::exception

Defined in header <exception>

```
class exception;
```

Provides consistent interface to handle errors through the throw expression.

All exceptions generated by the standard library inherit from **std::exception**

- logic_error
  - invalid_argument
  - domain_error
  - length_error
  - out_of_range
  - future_error(C++11)
- bad_optional_access(C++17)
- runtime_error
  - range_error
  - overflow_error
  - underflow_error
  - regex_error(C++11)
  - system_error(C++11)

* Source : https://en.cppreference.com/w/cpp/error/exception

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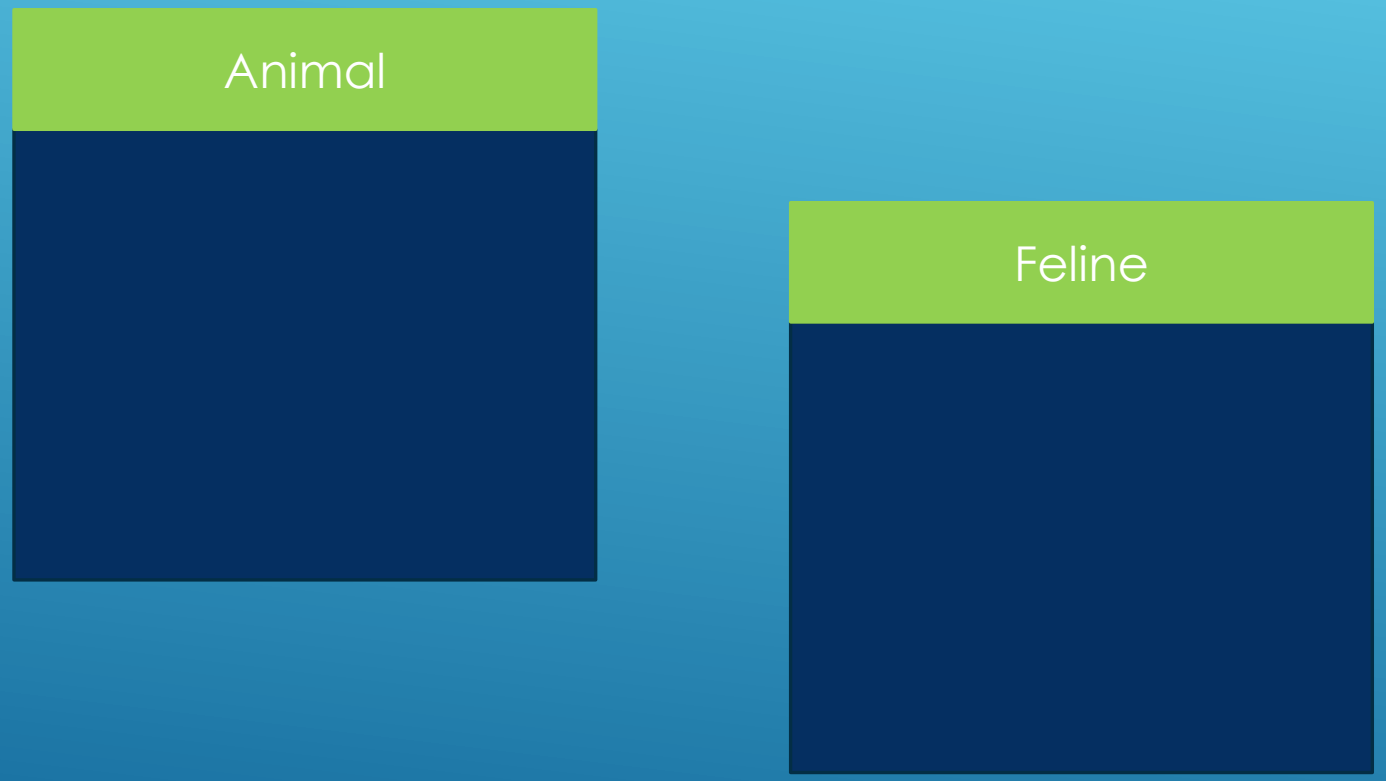
Catching Standard Exceptions


Animal
Feline

```
int main(int argc, char **argv)
{
    Animal animal1;

    try{
        Feline feline {dynamic_cast<Feline&>(animal1)};
    }catch(std::exception& ex){
        std::cout << "Something is wrong : " << ex.what() << std::endl;
    }

    return 0;
}
```

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Throwing standard exceptions

```
class Students{
public :
    Students() = delete;
    Students(std::string_view s1, std::string_view s2, std::string_view s3,
                std::string_view s4, std::string_view s5){
                m_students[0] = s1;m_students[1] = s2;
                m_students[2] = s3;m_students[3] = s4;
                m_students[4] = s5;
    }
    ~Students() = default;

    std::string_view get_student(size_t index){
        const std::string message = "Index out of range, valid range["
                + std::to_string(0) + "," + std::to_string(4)
                + "]";

        if( (index < 0) || (index >= 5))
            throw std::out_of_range(message);
        return m_students[index];

    }
private :
    std::string m_students[5];
};
```

```
int main(int argc, char **argv)
{
    Students students("John Snow", "Terry Boomd",
                      "Nicholai Itchenko" , "Bilom Atunde" , "Lily Park");

    try{
        std::cout << students.get_student(2) << std::endl;
        std::cout << students.get_student(-2) << std::endl;
    }catch(std::exception& ex){

        std::cout << "Exception cought : " << ex.what() << std::endl;
    }

    return 0;
}
```

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Deriving From Standard Exceptions


```
class DivideByZeroException : public std::exception {
public :
    DivideByZeroException(int a, int b) noexcept : std::exception(),m_a(a),m_b(b){}

     virtual const char* what() const noexcept override {
         return "Divide by zero detected";
     }

     int get_a() const{
         return m_a;
     }

     int get_b() const{
         return m_b;
     }

private :
     int m_a{};
     int m_b{};

};
```

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Exceptions : Summary

A C++ built in mechanism to bring problems to the surface and possibly handle them

- static_assert
- assert
- std::cout

Try catch blocks : Syntax

```
int a{10};
int b{0};

try{
    Item item; // When exception is thrown, control immediately exits the try block
               // an automatic local variables are released
               // But pointers may leak memory.
    if( b == 0 )
        throw 0;
    a++; // Just using a and b in here, could use them to do anything.
    b++;
    std::cout << "Code that executes when things are fine" << std::endl;

}catch(int ex){
    std::cout << "Something went wrong. Exception thrown : " << ex <<  std::endl;
}

std::cout << "END." << std::endl;
```

The need for exceptions : Integer division by 0

```
//int division by 0 : CRASH

const int a{45};
const int b{0};
int result = a/b;
```

The need for exceptions : Failing downcast

```
//Downcast using dynamic_cast with references
//The hierarchy of Animal->Dog has to be polymorphic to be able to do
//this. This throws an exception because animal has no dog part so the
//cast won't really work.

Animal a;
Dog& d{dynamic_cast<Dog&>(a)};
```

Handling exceptions at different levels

```
void f1(){
    std::cout << "Starting f1()" << std::endl;
    f2();
    std::cout << "Ending f1()" << std::endl;
}

void f2(){
    std::cout << "Starting f2()" << std::endl;
    f3();
    std::cout << "Ending f2()" << std::endl;
}

void f3(){
    std::cout << "Starting f3()" << std::endl;
    std::cout << "Ending f3()" << std::endl;
}
```

C:\Windows\SYSTEM32\cmd.exe

```
Starting f1()
Starting f2()
Starting f3()
Ending f3()
Ending f2()
Ending f1()
END.
```

Multiple handlers at different levels

```
void f1(){
    std::cout << "Starting f1()" << std::endl;
    try{
        f2();
    }catch(int ex){
        std::cout << "Handling execution in f1()" << std::endl;
    }
    std::cout << "Ending f1()" << std::endl;
}

void f2(){
    std::cout << "Starting f2()" << std::endl;
    f3();
    std::cout << "Ending f2()" << std::endl;
}

void f3(){
    std::cout << "Starting f3()" << std::endl;
    exception_thrower();
    std::cout << "Ending f3()" << std::endl;
}
```

C:\Windows\SYSTEM32\cmd.exe

```
Starting f1()
Starting f2()
Starting f3()
starting execution_thrower()
Handling execution in f1()
Ending f1()
END.
```

Nested try blocks

```
void some_function(){
    for(size_t i{} ; i < 15 ;++i){
        std::cout << "Iteration : " << i << std::endl;

        try{ // Outer try block
            //Exceptions thrown in this scope are
            //handled in outer catch blocks
            if(i ==2 ){
                throw "exception for int 2 thrown" ;// Throws const char*
            }

            try{ // Inner try block ...

        }
        catch(const char* ex){
            std::cout<< "Outer catch(const char*) block , cought  :" << ex  << std::endl;
        }
        catch(size_t ex){
            std::cout << "Outer catch(size_t) block, cought " << ex << std::endl;
        }
    }
}
```

Throwing class objects

```
class SomethingIsWrong{
public :
    SomethingIsWrong(const std::string s)
        : m_message(s)
        {
        }

    //Copy Constructor
    SomethingIsWrong(const SomethingIsWrong& source){

    //Destructor
    ~SomethingIsWrong(){
        std::cout << "SomethingIsWrong destructor called" << std::endl;
    }
    std::string_view what()const{
        return m_message;
    }
private :
    std::string m_message;
};
```

Class objects that are part of a inheritance hierarchy

```
class SomethingIsWrong{
public :
    SomethingIsWrong(const std::string& s) : m_message(s){}
     ~SomethingIsWrong(){}
     const std::string& what()const{return m_message;}
protected :
    std::string m_message;
};

class Warning : public SomethingIsWrong{
    public :
    Warning(const std::string& s) : SomethingIsWrong(s){}
};

class SmallError : public Warning{
    public :
    SmallError(const std::string& s) : Warning(s){}
};

class CriticalError : public SmallError{
    public :
    CriticalError(const std::string& s) : SmallError(s){}
};
```

Class objects that are part of a inheritance hierarchy

```
int main(int argc, char **argv)
{
    for(size_t i{0}; i < 5 ; ++i){

      try{
          do_something(i);
      }
      catch(CriticalError& ex){
          std::cout << "CriticalError Exception cought : " << ex.what() << std::endl;
      }
      catch(SmallError& ex){
          std::cout << "SmallError Exception cought : " << ex.what() << std::endl;
      }
      catch(Warning& ex){
          std::cout << "Warning Exception cought : " << ex.what() << std::endl;
      }
      catch(SomethingIsWrong& ex){
          std::cout << "SomethingIsWrong Exception cought : " << ex.what() << std::endl;
      }
    }
    return 0;
}
```

Polymorphic inheritance hierarchies

```
class SomethingIsWrong{
public :
    SomethingIsWrong(const std::string& s) : m_message(s){}
    virtual ~SomethingIsWrong(){}
    virtual const std::string& what()const{return m_message;}
protected :
    std::string m_message;
};

class Warning : public SomethingIsWrong{
    public :
    Warning(const std::string& s) : SomethingIsWrong(s){}
};

class SmallError : public Warning{
    public :
    SmallError(const std::string& s) : Warning(s){}
};

class CriticalError : public SmallError{
    public :
    CriticalError(const std::string& s) : SmallError(s){}
};
```

Polymorphic inheritance hierarchies

```
int main(int argc, char **argv)
{
    std::cout << "Object Exceptions with Class Inheritance Hierarchies" << std::endl;

    for(size_t i{0}; i < 5 ; ++i){

      try{
          do_something(i);
      }

      catch(SomethingIsWrong& ex){
          std::cout << "SomethingIsWrong Exception cought : " << ex.what() << std::endl;

          //Using typeid()
          //std::cout << typeid(ex).name()  << "Exception cought : " << ex.what() << std::endl;
      }
    }
    return 0;
}
```

Rethrown exceptions

```
for(size_t i{0}; i < 5 ; ++i){
    try{
        try{
            do_something(i);
        }
        catch(SomethingIsWrong& ex_inner){
            if(typeid(ex_inner) == typeid(Warning)){
                std::cout << typeid(ex_inner).name()  <<
                    " -Inner catch block ,Exception cought : " <<
                    ex_inner.what() << std::endl;
            }else{
                throw;
                //throw ex_inner;//This will do a copy, and there will be slicing.Beware.
            }
        }
    }
    catch(SomethingIsWrong& ex_outer){
        std::cout << typeid(ex_outer).name() <<
                " -Outer catch block, Exception cought : " <<
                    ex_outer.what() << std::endl;
    }
}//End of for loop
```

Program custom termination

```
void our_terminate_function(){
    std::cout << "Our custom terminate function called" << std::endl;
    std::cout << "Program will terminate in 10s ..." << std::endl;
    //std::this_thread::sleep_for(std::chrono::milliseconds(10000));
    std::abort();
}

int main(int argc, char **argv)
{
    std::set_terminate(&our_terminate_function);
     /*
    std::set_terminate([](){
            std::cout << "Our custom terminate function called" << std::endl;
            std::cout << "Program will terminate in 10s ..." << std::endl;
            std::this_thread::sleep_for(std::chrono::milliseconds(10000));
            std::abort();
    });
    */

    throw 1;

    return 0;
}
```

Ellipsis catch all block

```
int main(int argc, char **argv)
{
    try{
        for( size_t i{}; i < 5; ++i){
            try{
                some_function(i);
            }
            catch(int ex){
                std::cout << "int handler- Cought an integer" << std::endl;
            }
            catch(...){
                std::cout << "Inner... handler , Cought some exception" << std::endl;
               // throw;
            }
        }
    }
    catch(const std::string& ex){
        std::cout << "Cought some string exception" << std::endl;
    }
    catch(...){
        std::cout << "Outer ...handler cought some other exception" << std::endl;
    }
    return 0;
}
```

noexcept specifier

```
void some_function() noexcept{

    try{
        throw 1;
    }
    catch(int ex){
        std::cout << "Handling int excpetion in free function some_function()" << std::endl;
        throw;
    }

}
```

Noexcept destructors

```
class Item{
public :
    Item(){}
    ~Item(){
    throw;
    }
};
```

Standard exceptions

```
exception

logic_error                runtime_error              others

    . invalid_argument         . overflow_error           . bad_alloc
    . length_error             . underflow_error          . bad_cast
    . out_of_range
```

Standard exceptions

```
exception

logic_error                runtime_error              others

    . invalid_argument         . overflow_error           . bad_alloc
    . length_error             . underflow_error          . bad_cast
    . out_of_range
```

- Catching/Handling
- Throwing
- Deriving

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