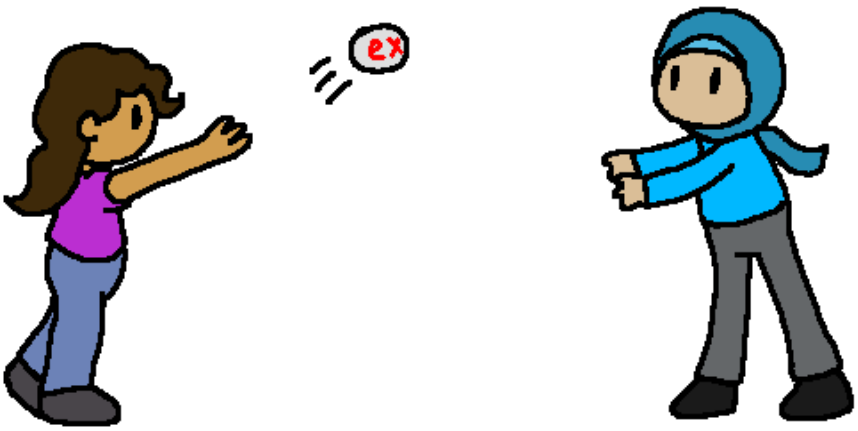
Core Computer Science Notes: Exception Handling



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Topic 1

Exception Handling

1.1 Writing robust software

As a software developer, you will often be writing software that other developers will be using. This could be other developers at the company working on the same software product, or perhaps you might write a library that gets licensed out to other companies, or anything else. Your code will need to have checks in place for errors and be able to manage those errors gracefully, allowing the software to continue running instead of letting the program crash and restart.

A long time ago, lots of developers used numeric error codes to track errors. If you've ever seen something like "Error 12943" with no other useful information, that is an example of these error codes - useless for the end-user, but meant so that the programmer can search the code for that number and find where it broke. This is also why we use **return 0** at the end of our C++ programs - technically, you could return anything else, but returning 0 is meant to show that there were no errors. If you ran into an error, you *could* return 1 or 2 or 3 instead to mark errors.

Modern languages have **exception handling** built in, usually working with a **try/catch** style. You write in logic to check for errors, and when you find a problem you **throw** an exception, and that exception can be **caught** elseware in the code.

What kind of errors can we listen for?

- Trying to open a file that doesn't exist
- Memory access violations
- Invalid math (dividing by 0)
- Not enough memory
- Receiving unexpected inputs
- Trying to delete from an empty data structure
- Problem converting one data type to another

1.2 The C++ Exception object

C++ has an **exception** family of objects that we can use when trying to classify what kind of exception has happened. If none of the existing exception objects is appropriate, you can also create your own exception type.

You can find documentation for the exception object here:
`http://www.cplusplus.com/reference/exception/exception/`

Exceptions: [1]

bad_alloc	Exception thrown on failure allocating memory
bad_cast	Exception thrown on failure to dynamic cast
bad_exception	Exception thrown by unexpected handler
bad_function_call	Exception thrown on bad call
bad_typeid	Exception thrown on typeid of null pointer
bad_weak_ptr	Bad weak pointer
ios_base::failure	Base class for stream exceptions
logic_error	Logic error exception
runtime_error	Runtime error exception
domain_error	Domain error exception
future_error	Future error exception
invalid_argument	Invalid argument exception
length_error	Length error exception
out_of_range	Out-of-range exception
overflow_error	Overflow error exception
range_error	Range error exception
system_error	System error exception
underflow_error	Underflow error exception
bad_array_new_length	Exception on bad array length

[1] From http://www.cplusplus.com/reference/exception/exception/

1.3 Detecting errors and throwing exceptions

The first step of dealing with exceptions is identifying a place where an error may occur - such as a place where we might end up dividing by zero. We write an **if statement** to check for the error case, and then **throw** an exception. We choose an exception type and we can also pass an error message as a string.

```
1 int ShareCookies( int cookies, int kids )
2 {
3     if ( kids == 0 )
4     {
5         throw runtime_error( "Cannot divide by zero!" );
6     }
7
8     return cookies / kids;
9 }
```

1.4 Listening for exceptions with try

Now we know that the function `ShareCookies` could possibly throw an exception. Any time we call that function, we need to listen for any thrown exceptions by using **try**.

```
1 try
2 {
3     // Calling the function
4     cookiesPerKid = ShareCookies( c, k );
5 }
```

1.5 Dealing with exceptions with catch

Immediately following the **try**, we can write one or more **catch** blocks for different types of exceptions and then decide how we want to handle it.

```
try
{
    // Calling the function
    cookiesPerKid = ShareCookies( c, k );
}
catch( runtime_error ex )
{
    // Display the error message
    cout << "Error: " << ex.what() << endl;

    // Handling it by setting a default value
    cookiesPerKid = 0;
}

cout << "The kids get " << cookiesPerKid
    << " each" << endl;
```

A function could possibly throw different types of exceptions for different errors, and you can have multiple **catch** blocks for each type.

Handling the error: Once you catch an error, it's up to you to decide what to do with it. For example, you could...

- Ignore the error and just keep going
- Write some different logic for a "plan B" backup
- End the program because now the data is invalid

Coding with others' code: While writing software and utilizing others' code, you will want to pay attention to which functions you're calling that could throw exceptions. Often code libraries will contain documentation that specify possible exceptions thrown.