Module 9

"Structured Exception Handling"

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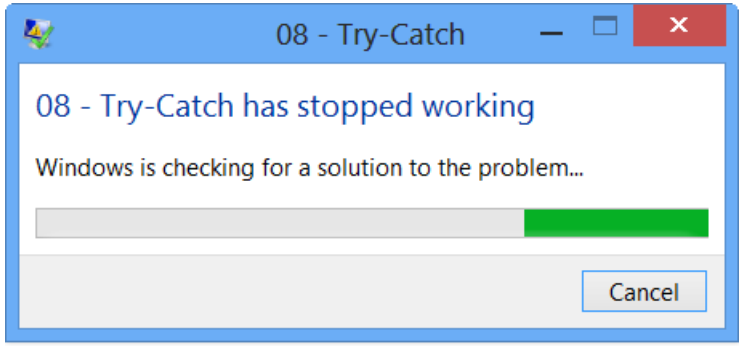
Agenda

- Introducing Exceptions
- Catching Exceptions
- Throwing Exceptions
- Defining Custom Exceptions
- Lab 9
- Discussion and Review

What are Exceptions?

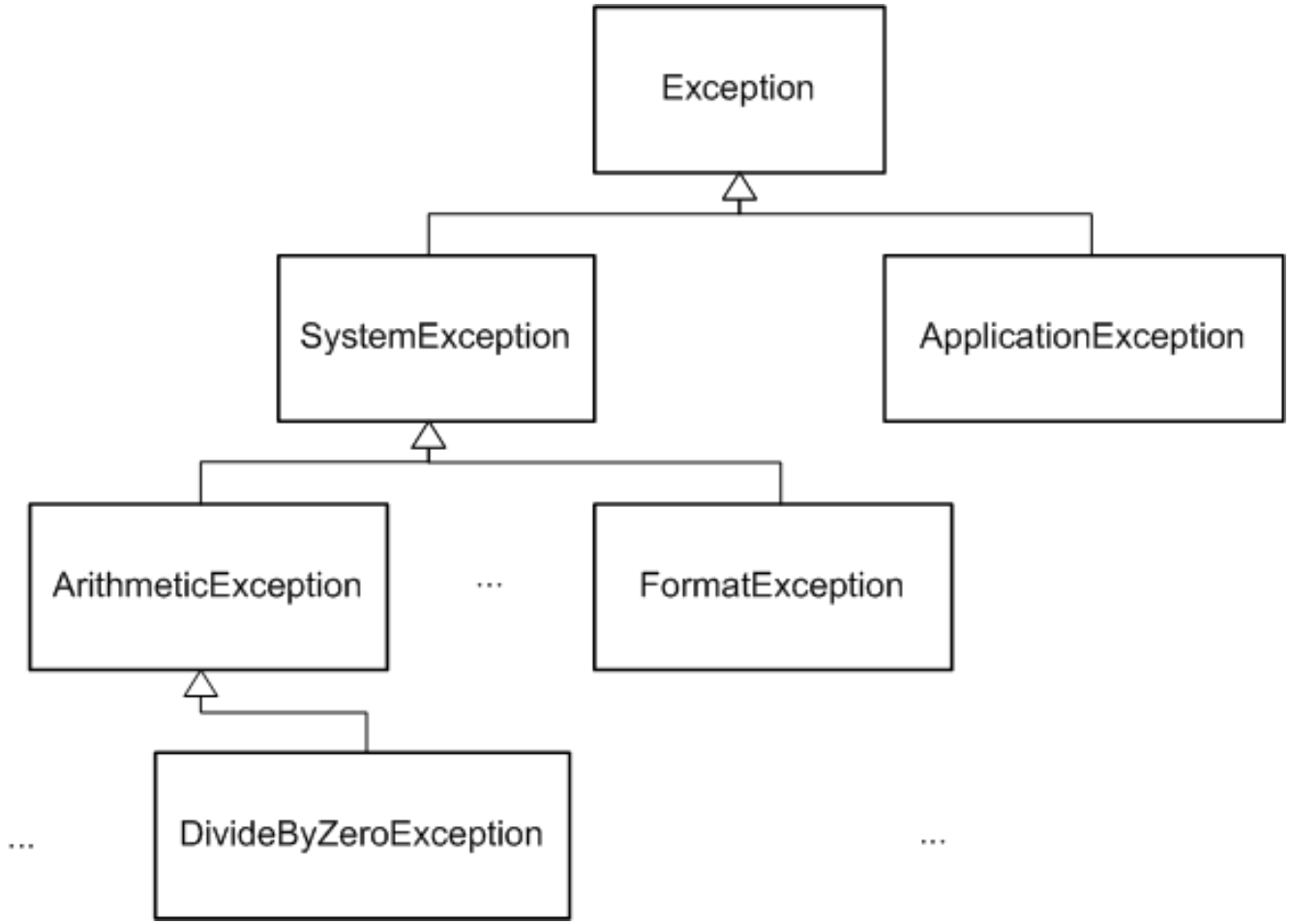
- Well…



Why Exceptions?

```
int rc = 0;
Start:
rc = OpenFile( "Hello.txt" );
if( rc == -1 ) goto FileNotFound;
rc = GetFileContents();
if( rc == 87 ) goto FileEmpty;
rc = ConvertContents();
if( rc == 112 ) goto IllegalContents;
goto Succeeded;
FileNotFound: goto Start;
FileEmpty: goto Failed;
IllegalContents: goto Failed;
Succeeded: Console.WriteLine( "Yeah!" );
Failed: ...;
```

The Hierarchy of Exceptions



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The `try-catch` Construct

- Perform application logic in a **`try`**-block
- Deal with exceptions in a **`catch`**-block

```
try
{
   Console.WriteLine( "Enter a number: " );
   int i = int.Parse( Console.ReadLine() );
   Console.WriteLine( "You entered the number {0}", i );
}
catch( FormatException exception )
{
   Console.WriteLine( exception );
}
```

- The exception variable is scoped to the **`catch`**-block only

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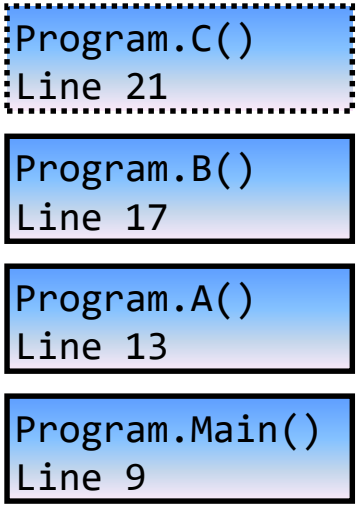
Understanding Exceptions: The Call Stack

```
static void Main()
{
   A();
}
static void A()
{
   B();
}
static void B()
{
   C();
}
static void C()
{
   Console.Write(" In C" );
}
```



Call Stack

Core Members of `System.Exception`

Name	Characteristics
`Data`	Additional data in the shape of key/value pairs
`HelpLink`	URL to file or website
`InnerException`	Previous exceptions
`Message`	Textual description
`Source`	Name of assembly throwing the exception
`StackTrace`	Call stack
`TargetSite`	Details of the method throwing the exception

Multiple `catch`-blocks

- Multiple **`catch`**-blocks can be applied when distinct types of exceptions need to be treated

```
try
{
   Console.WriteLine( "Enter a number: " );
   int i = int.Parse( Console.ReadLine() );
   Console.WriteLine( "You entered the number {0}", i );
}
catch( OverflowException caught ) { ... }
catch( FormatException exception ) { ... }
```

- Blocks must be ordered from most specific first to most general last
- Only catch exceptions that you can do something about…

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The Generic `catch`

- A generic **`catch`**-block anonymously catches all exceptions

```
try
{
   Console.WriteLine( "Enter a number: " );
   int i = int.Parse( Console.ReadLine() );
   Console.WriteLine( "You entered the number {0}", i );
}
catch
{
   Console.WriteLine( "Something went haywire..!" );
}
```

- This is equivalent to

```
catch( Exception exception )
{
   Console.WriteLine( "Something went haywire..!" );
}
```

Which Classes Throw Which Exceptions?

```
try
{
    Console.WriteLine( "Enter a number: " );
    int i = int.Parse( Console.ReadLine() );
    Console.Writ
}
catch( OverflowE
{
    Console.Writ
}
catch( FormatExc
{
    Console.WriteLine( exception );
}
catch
{
    Console.WriteLine( "Something went haywire..!" );
}
```

int int.Parse(string s) (+ 3 overload(s))
Converts the string representation of a number to its 32-bit signed integer equivalent.

Exceptions:
- System.ArgumentNullException
- System.FormatException
- System.OverflowException

Visual Studio is Your Friend

- Use the tools of Visual Studio to both inspect, detect, and prevent exceptions!
- Use the Exception Settings Window to break when certain exceptions are thrown
  - Locate this at "Debug" -> "Windows" -> "Exception Settings…"
- Step through the code with F5, F10, F11

- Set breakpoints to pause execution at specific points
  - These can be parameterized by conditions
  - The items at the bottom of the "Debug" menu
  - You can even change values

- Note: Visual Studio treats exceptions in two different ways
  - With debugger: Breaks at original exception location
  - Without debugger: Displays OS's exception dialog

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The `throw` Keyword

- It is possible to directly throw exceptions via the **`throw`** keyword

```
Console.WriteLine( "Enter a number: " );
int i = int.Parse( Console.ReadLine() );
Console.WriteLine( "Enter another number: " );
int j = int.Parse( Console.ReadLine() );

if( i == j )
{
   throw new ArgumentException( "Identical numbers entered!" );
}
```

Re-throwing Exceptions

```
try
{
   Console.WriteLine( "Enter a number: " );
   int i = int.Parse( Console.ReadLine() );
   Console.WriteLine( "You entered the number {0}", i );
}
catch( OverflowException )
{
  Console.WriteLine( "Cannot deal with overflow here! :-(" );
  throw;
}
```

- The variable in the **`catch`** can be omitted if not used

The `finally`-block

- The statements in a **`finally`** block are always executed – even in the presence of exceptions!

```
SqlConnection connection = new SqlConnection();
try
{
   connection.Open();
}
finally
{
   connection.Close();
}
```

- The **`catch`** blocks are optional when there is a **`finally`**-block

Quiz: `try-catch-finally`

```
try
{
   Console.WriteLine( "try" );

   throw new Exception();
}
catch( Exception )
{
   Console.WriteLine( "catch" );

   return;
}
finally
{
   Console.WriteLine( "finally" );
}
```

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A Custom Exception Class

- You can easily create your own custom exceptions

```
public class TicketSalesException : Exception
{
    public TicketSalesException()
    {
    }
    public TicketSalesException( string message )
        : base( message )
    {
    }
    public TicketSalesException( string message,
                                 Exception inner )
        : base( message, inner )
    {
    }
}
```

Inner Exceptions

- If specified, the **InnerException** property supplies the original exception

```
try
{
   Console.WriteLine( "{0} was just requested", EnterTickets() );
}
catch( TicketSalesException e )
{
   Console.WriteLine( e );
   if( e.InnerException != null )
   {
      Console.WriteLine( "Technical info: " + e.InnerException );
   }
}
```

- In fact, the exception given by **InnerException** may in turn have inner exceptions.

Exception Filters

- New in C# 6.0: Exception Filters!
  - facilitate the handling of exceptions matching a specific type and/or condition

```
try
{
   Console.WriteLine( "{0} was just requested", EnterTickets() );
}
catch( TicketSalesException e ) when ( e.InnerException != null )
{
   // Catch only when there is an inner exception present

   Console.WriteLine( e );
   Console.WriteLine( "Technical info: " + e.InnerException );
}
```

- Distinct clauses can match same exception type but with different conditions

Best Practices for Exceptions

- Use exceptions only for *exceptional* cases

- Only catch exceptions you can handle
- Don't let any exceptions slip out of your program or component
  - Create an exception filter!

- Throw exception objects of a type as specific as possible
- Never throw a generic **`Exception`**

- Make your own exception classes public
- Implement the three "standard" constructors (*)
- The "**`Exception`**/**`ApplicationException`**" Controversy

Lab 9: Implementing Exception Handling

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Discussion and Review

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