UofSC

Exceptions

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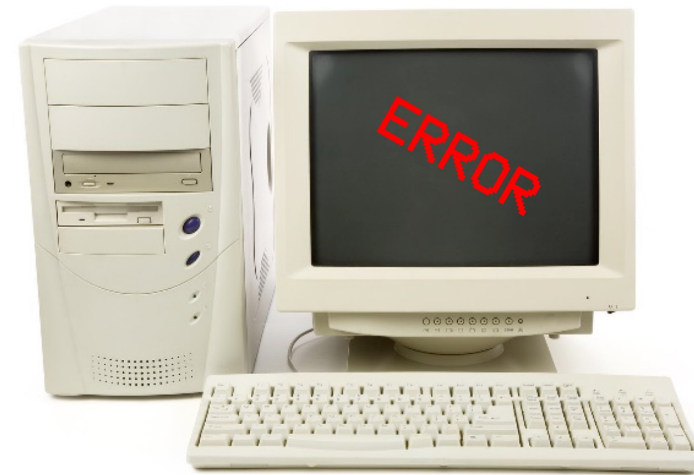
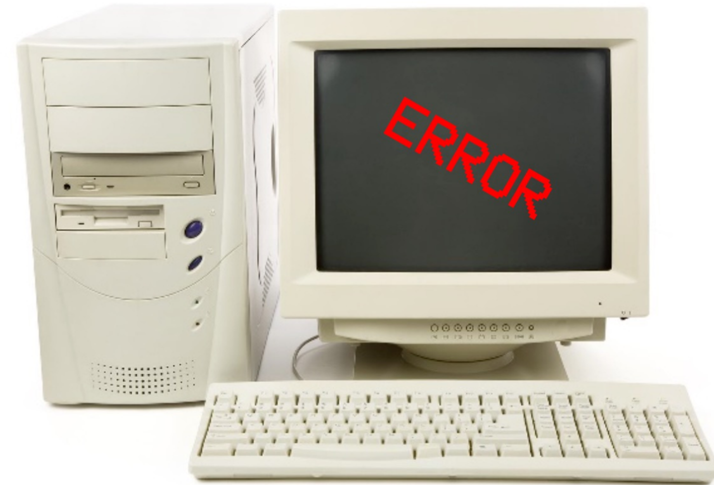
Exceptions

- Exceptions signals an *exceptional* occurrence during run-time
- Handles run-time errors by allowing the program to *crash gracefully* and keep executing
- Exceptions are Objects
  - These Objects have an “exception message”
- “Throwing” an exception is when an exception object is created
- “Handling” an exception is when special code detects and deals with the exceptional occurrence



Exceptions

- 3 Major Parts to Exceptions
  1. Creating Exceptions
  2. Throwing (Using) Exceptions
  3. Handling Exceptions



Creating Exceptions

- In Java there are several predefined exceptions
  - Exception (most general)
  - NullPointerException
  - IndexOutOfBoundsException
  - IOException
- Creating a specific kind of Exception involves inheriting from one of the predefined Exceptions
- Only write the Constructors
  - Make sure to use “super” to construct the superclass Exception
  - Set the exception message
  - Do not override “getMessage”

Syntax for Creating an Exception

```
public class <<id>> extends <<an Exception>>
{
	<<constructors>>;
}
```

Example

```
public DivideByZeroException extends Exception
{
	public DivideByZeroException()
	{
		super(“Attempted to Divide by Zero”);
	}
	public DivideByZeroException(String msg)
	{
		super(msg);
	}
}
```

Creating Exceptions

- When a method could cause an Exception, then then programmers need to be notified to handle it
- The reserved word “throws” is used in the method signature to indicate the method could cause an exception
- Each exception is listed by their identifier and are separated using a comma

<u>Syntax for a Method that throws an Exception</u>

```
<<scope>> <<return type>> <<method id>> (<<parameters>>)
throws <<List of Exceptions>>
{
      <<method body>>
}
```

<u>Example</u>

```
public double evaluate(char op, double n1, double n2)
throws DivideByZeroException, UnknownOpException
{
      …
}
```

Creating Exceptions

- When a method could cause an Exception, then then programmers need to be notified to handle it
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Example

```
public double evaluate(char op, double n1, double n2)
throws DivideByZeroException, UnknownOpException
{
      …
}
```

Throwing Exceptions

- In a method that *throws* exceptions there should be cases where that kind of exception happens
- The reserved word "throw" is used when an exception occurs
  - Method signature uses "throws"
  - Method body uses "throw"
- Follow "throw" by then constructing an instance of that kind of exception

Syntax for Throwing the Exception

```
throw new <<Exception Constructor>>
```

Example

```
…
//Inside of method evaluate
…
throw new DivideByZeroException();
…
```

Throwing Exceptions

- In a method that *throws* exceptions there should be cases where that kind of exception happens
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  - Method signature uses "throws"
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Syntax for Throwing the Exception

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```

Example

```
…
//Inside of method evaluate
…
throw new DivideByZeroException();
…
```

Handling Exceptions

- Methods that *throws* exceptions must be handled in a “try-catch” block
- The method that could cause the exception must be within the body of the try-block
  - Otherwise the method would cause a syntax error
- The exception that is handled must be declared in the arguments of the catch-block
  - Exception type followed by an identifier
- The exception is then handled in the body of the catch-block
  - Usually a good idea to print the exception message using either “getMessage” or “printStackTrace”

<u>Handling an Exception</u>

```
try
{
	<<Method that throws the Exception>>
}
catch(<<Exception type>> <<id>>)
{
	<<Handle the Exception>>
}
```

<u>Example</u>

```
try
{
	…
	result = evaluate(nextOp, result, nextNumber);
	…
}
catch(DivideByZeroException e)
{
	e.printStackTrace();
}
```

Handling Exceptions

- If a method causes an exception in the try-block then the program immediately *jumps* to the corresponding catch-block
- After the exception has been handled the program continues after the try-catch block
- A try-catch block can only have 1 try-block and may have 1 or more catch-blocks
- Multiple Catch-blocks must be ordered from most specific exception to least specific exception
  - Otherwise causes an unreachable code syntax error
  - Most general exception is "Exception"
- With multiple catch-blocks the most appropriate catch-block runs corresponding to the exception that was thrown

Syntax for Handling a Multiple Exception

```
try
{
	<<Method that throws the Exceptions>>
}
catch(<<Most Specific Exception type>> <<id>>)
{
	<<Handle the Most Specific Exception>>
}
…
catch(<<Most General Exception type>> <<id>>)
{
	<<Handle the Most General Exception>>
}
```

Handling Exceptions

- If a method causes an exception in the try-block then the program immediately *jumps* to the corresponding catch-block
- After the exception has been handled the program continues after the try-catch block
- A try-catch block can only have 1 try-block and may have 1 or more catch-blocks
- Multiple Catch-blocks must be ordered from most specific exception to least specific exception
  - Otherwise causes an unreachable code syntax error
  - Most general exception is "Exception"
- With multiple catch-blocks the most appropriate catch-block runs corresponding to the exception that was thrown

<u>Example</u>

```
try
{
        …
        result = evaluate(nextOp, result, nextNumber);
        …
}
catch(DivideByZeroException e)
{
        e.printStackTrace();
}
catch(UnknownOpException e)
{
        e.printStackTrace();
}
catch(Exception e)
{
        e.printStackTrace();
}
```

Handling Exceptions

- A "finally" block can be optionally added after a sequence of catch-blocks
- The code in the finally-block will execute whether or not an exception is thrown

Finally Block Syntax

```
try
{
        <<Method that throws the Exception>>
}
catch(<<Exception type>> <<id>>)
{
        <<Handle the Exception>>
}
finally
{
        <<code that will execute with or without exceptions>>
}
```

Example

```
try
{
        …
        result = evaluate(nextOp, result, nextNumber);
        …
}
//Catches
finally
{
        System.out.println("result = " + result);
}
```

Calculator Example

- Problem: We must create a simple calculator program
- Keeps track of a resulting value
- Performs the operations
  - Addition
  - Subtraction
  - Multiplication
  - Division
- User provides input via the console
- Input follows <<operator>> <<value>>
  - Example “+ 3”

- Must handle a variety of exceptions while keeping the program running

Calculator Example

```java
/*
 * Written by JJ Shepherd
 */
public class DivideByZeroException extends Exception
{
	public DivideByZeroException()
	{
		super("Dividing by Zero!");
	}
	public DivideByZeroException(String msg)
	{
		super(msg);
	}
}
```

```java
/*
 * Written by JJ Shepherd
 */
public class UnknownOpException extends Exception
{
	public UnknownOpException()
	{
		super("Tried to use an unknown operator");
	}
	public UnknownOpException(String msg)
	{
		super(msg);
	}
}
```

```java
public double evaluate(char op, double n1, double n2)
throws DivideByZeroException, UnknownOpException
{
	double answer = 0.0;
	switch(op)
	{
	case '+':
		answer = n1 + n2;
		break;
	case '-':
		answer = n1 - n2;
		break;
	case '*':
		answer = n1 * n2;
		break;
	case '/':
		if((-PRECISION < n2) && (n2 < PRECISION))
			throw new DivideByZeroException();
		answer = n1 / n2;
		break;
	default:
		throw new UnknownOpException(op+" was used");
	}
	return answer;
}
```

Handling Additional Arguments

- You can have an exception with additional arguments that you then use to create a message

```
public InvalidOpinionException(String opinion, String permittedOpinion) {
        super("Your opinion '" + opinion + "' is not permitted. An example of a 
        permitted opinion is " + permittedOpinion);
}
```

Handling Additional Arguments

```
public InvalidOpinionException(String opinion, String permittedOpinion) {
        super("Your opinion '" + opinion + "' is not permitted. An example of a permitted opinion is " + permittedOpinion);
}
```

```
    public static void main(String[] args) throws InvalidOpinionException {
        Scanner scanner = new Scanner(System.in);
        Set<String> permittedOpinions = new HashSet<String>();
        permittedOpinions.add("Pineapples go on pizza.");
        permittedOpinions.add("Go Gamecocks!");
        String opinion = scanner.nextLine();
        if (permittedOpinions.contains(opinion)) {
            System.out.println("Congratulations!");
        } else {
            scanner.close();
            throw new InvalidOpinionException(opinion, getRandomElement(permittedOpinions));
        }
        scanner.close();
    }
```

```
Pineapples go on pizza.
Congratulations!
```

```
Go Clemson!
Exception in thread "main" InvalidOpinionException: Your opinion
'Go Clemson!' is not valid. An example of a valid opinion is Go
Gamecocks!
at InvalidOpinionException.main(InvalidOpinionException.java:26)
```